NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
PREVENTION AND PROTECTION START HERE

Final Public Health Review Report

Camp Justice
Naval Station Guantanamo Bay, Cuba

03 March 2017

This page has been left blank to allow for double-sided printing.

Abstract

On 23 July 2015, in response to a hotline complaint received by the Department of Defense (DoD) Inspector General (IG), the Navy and Marine Corps Public Health Center (NMCPHC) was asked by Commander Navy Region Southeast (CNRSE) to conduct a Public Health Review (PHR) of the area surrounding the DoD Office of Military Commissions' (OMC) trailers, tents, offices, and courtroom buildings located on Camp Justice at Naval Station Guantanamo Bay (NSGB). The hotline complaint alleged that:

- Since 2004, military and civilian members working for OMC have been exposed to carcinogens in an area surrounding the Commissions' trailers, tents, offices, and courtrooms;
- The area may have been a dumping ground for fuel in the past; and
- The old Commissions' building potentially contains asbestos and possibly other carcinogens and the new Commissions' building was built on the old runway and could be contaminated.

This PHR found no evidence that the area was used as a dumping ground for fuel in the past, that the old runway is contaminated, or that there are complete exposure pathways (air, water, soil) resulting in risks to carcinogens above the acceptable risk range established by the United States Environmental Protection Agency (USEPA).[1] Four (4) different cancer types were validated in five (5) individuals out of 700 OMC Active Duty Military who served at Camp Justice between 2004 – 2016. For two (2) of the types of cancers at Camp Justice (appendiceal adenocarcinoid and colorectal), there are no known environmental risk factors. For the other two types of cancers (breast and myxoid liposarcoma), the only common environmental risk factor is exposure to ionizing radiation. Ionizing radiation was evaluated at Camp Justice and it was concluded based on the results of the radiation surveys and measurements conducted, it is not likely that an individual would receive any additional radiation dose above the normal background radiation from the occupied areas surrounding the OMC's trailers, tents, offices, and courtroom buildings located on Camp Justice.

Therefore, based on the types and number of cancers observed, and the lack of recognized occupational and environmental risk factors, it is unlikely that an environmental or occupational exposure is associated with these cancers. The term "unlikely" means that the evidence is insufficient to connect the environmental and occupational conditions to the observed cancers.

The PHR recommends a number of risk management actions (primarily administrative actions) based on the findings of the PHR which should be implemented to monitor and ensure that conditions at Camp Justice remain protective of human health. To the extent practicable, these recommendations should be applied at other installations that have the potential for the same programmatic issues.

[1]The USEPA recommends using an acceptable cancer risk range of 1.0E-04 (1×10^{-4} or 1 in 10,000) to 1.0E-06 (1×10^{-6} or 1 in 1,000,000).

This page has been left blank to allow for double-sided printing.

Executive Summary

On 23 July 2015, in response to a hotline complaint received by the Department of Defense (DoD) Inspector General (IG), the Navy and Marine Corps Public Health Center (NMCPHC) was asked by Commander Navy Region Southeast (CNRSE) to conduct a Public Health Review (PHR) of the area surrounding the DoD Office of Military Commissions' (OMC) trailers, tents, offices, and courtroom buildings located on Camp Justice at Naval Station Guantanamo Bay (NSGB).

The hotline complaint alleged that:

- Since 2004, military and civilian members working for OMC have been exposed to carcinogens in an area surrounding the Commissions' trailers, tents, offices and courtrooms;
- The area may have been a dumping ground for fuel in the past; and
- The old Commissions' building potentially contains asbestos and possibly other carcinogens and the new Commissions' building was built on the old runway and could be contaminated.

This Final PHR Report describes actions taken at Camp Justice between July 2015 and February 2017 to address the DoD IG complaint, which included:

- Performing both a preliminary and final public health review risk assessment
- Performing an epidemiological review of medical databases to identify and confirm the diagnosis of cancer and the type of cancer
- Reviewing medical literature to determine known environmental risk factors for each confirmed cancer type
- Gathering and reviewing available historical occupational and environmental records
- Conducting multiple on-site reconnaissance, scoping and environmental sampling visits of living and working environments (exposure assessment)
- Assessing the need for collecting additional environmental data to fill identified data gaps
- Developing a PHR Website[2] to include the following documents:
  - Seven (7) Occupational and Environmental Technical Reports
  - Thirteen (13) Fact Sheets
  - Frequently Asked Questions
  - Nine (9) Public Updates

[2]http://www.cnic.navy.mil/regions/cnrse/installations/ns_guantanamo_bay/om/environmental_support/Guantanamo_Bay_PHR.html

- Multiple Briefing Materials

PHR investigations are complex, take time, and are typically comprised of multiple iterative steps, with each step building on the previous step. A very conservative, health-protective, and comprehensive approach has been taken to investigate the potential health concerns at Camp Justice. The Navy and OMC have taken action where necessary in response to information obtained during the PHR as opposed to waiting for the PHR to be completed to take action. This Executive Summary condenses the results of the following sections of the PHR:

- Human Health Risk Assessment (HHRA)
- Epidemiology Investigation
- Conclusions/Findings
- Recommended Risk Management Actions

HHRA Summary

In February 2016, NMCPHC developed a preliminary public health screening risk assessment (Appendix H; NMCPHC 2016b) to determine if any immediate risk management actions were needed prior to completion of the final HHRA (see Section 2 – Human Health Risk Assessment, and Appendix C – Naval Station Guantanamo Bay Human Health Risk Assessment for Camp Justice February 2017). In the screening assessment, chemical of potential concern (COPC) concentrations were compared to United States Environmental Protection Agency (USEPA) screening levels (SLs; e.g., regional screening levels [RSLs]), USEPA Maximum Contaminant Levels (MCLs), and Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). This February 2016 screening risk assessment was considered preliminary because it did not address cumulative risk from all pathways of exposure and all COPCs. Further, not all of the data gaps (e.g., Air Curtain Incinerator [ACI] emissions, additional mercury sampling) were addressed.

The results of the preliminary public health screening risk assessment indicated that mercury and formaldehyde concentrations in indoor air, and arsenic and benzo(a)pyrene concentrations in soil were of potential concern and warranted further evaluation at specific locations in Camp Justice.[3] Mercury concentrations in indoor air, collected in October 2015 from immediately above the floor level of Building AV-29, exceeded the SL. In response to these exceedances, additional mercury samples were collected from the breathing zone of Building AV-29 during an

[3]The mercury and formaldehyde concentrations in indoor air were below OSHA PELs for employee occupational exposure in the workplace; however, this comparison did not consider cumulative risks related to multiple chemicals and pathways of exposure.

April 2016 sampling event. All additional sample results were not detected and were below the SL. Based on these results, no further action was recommended for indoor air at Building AV-29 and therefore mercury was not included in the final HHRA. However, formaldehyde, arsenic and polycyclic aromatic hydrocarbons were addressed in this final HHRA.

The purpose of the final HHRA was to characterize cumulative current and future potential health risks related to environmental sources within Camp Justice and the ACIs at NSGB. Data and information included in the February 2016 NMCPHC Preliminary Public Health Risk Screening Assessment Report were integrated into this Final PHR Report with data collected from the ACIs to calculate cumulative cancer risks and/or noncancer hazard indices (HIs) for all COPCs and all complete exposure pathways (e.g., inhalation of indoor air, inhalation of outdoor air, ingestion of soil, and dermal contact with soil [Appendix H; NMCPHC 2016b). See Section 2 (Human Health Risk Assessment) of this report for a full discussion. The Final HHRA also integrated the results of the following sources of data to include:

1. Measured data from soil, air, and tap water samples collected in October 2015 and April 2016 Inside Camp Justice; and
2. Modeled data from air dispersion and deposition modeling of ACI emissions.

Most of the chemical concentrations measured and modeled were evaluated quantitatively in the HHRA. A few other chemicals were either quantitatively evaluated using appropriate exposure models (lead) or discussed in detail in the text (e.g., asbestos and ionizing radiation). Cancer risks and HIs were calculated in this final HHRA for workers and residents assigned to Camp Justice and NSGB for 9-months, 3-years, 6-years, and 25-years using USEPA Superfund methodologies in which upper-bound risk estimates are derived to ensure a health-protective assessment that does not underestimate the risks. Some individuals, on temporary additional duty (TAD) orders, may spend as little as a few days to a few weeks, several times a year, at Camp Justice. Cancer risks and HIs would be lower for populations spending less time at Camp Justice than calculated in the above exposure groups.

Results for Chemicals Evaluated in the HHRA

Current and future potential cancer risks related to environmental sources within Camp Justice and the ACIs were within the USEPA acceptable risk range of 1E-06 to 1E-04 (e.g., 1 in 1,000,000 to 1 in 10,000). The cumulative cancer risk for Camp Justice for all COPCs ranged from 1.2E-07 to 6.1E-05. The HI exceeded the USEPA noncancer benchmark of one, for a number of exposure scenarios evaluated. Cumulative noncancer HIs for Camp Justice for all COPCs ranged from 0.2 to 5.1 (see Table 2-2). Most of the cumulative risks and HIs were due to formaldehyde in the indoor air of modular buildings. The concentrations of formaldehyde detected in indoor air at Camp Justice were within the range of concentrations considered "Low" to "Mid" by the Centers

of Disease Control and Prevention (CDC)[4] for typical concentrations observed in manufactured homes. Since formaldehyde was detected at typical United States (US) background concentrations in manufactured homes, cancer risks and hazards were also calculated without formaldehyde concentrations. The cumulative risks Inside Camp Justice, when formaldehyde was removed from the calculations, significantly decreased for most exposure scenarios (see Table 2-3). Formaldehyde sampling conducted after engineering controls were established (e.g., heating, ventilation and air conditioning equipment modifications) indicated that engineering controls were effective at significantly reducing the formaldehyde levels (e.g., 63% decrease in the average formaldehyde concentration) in almost all modular buildings. The contribution of ACI emissions to cancer risks and noncancer hazards associated with working and living in quarters or neighborhoods both inside and outside Camp Justice were negligible and not a health concern.

Other Results

Lead

Lead risks for children and adults were evaluated using the USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model and Adult Lead Methodology (ALM) Model. Lead risks to children and adult workers at NSGB were below the levels of concern established by the CDC of 5 µg/dL and the USEPA of 10 µg/dL. No action is recommended based on these predicted results.

Criteria Air Pollutants

Outdoor air concentrations were compared to the six air pollutants regulated by the National Ambient Air Quality Standards (NAAQS). These six pollutants include carbon monoxide, nitrogen dioxide, ozone, particulate pollution (referred to as particulate matter or PM), sulfur dioxide, and lead. The results indicated that there were only exceedances at three locations where people do not live or work. These locations include an area immediately next to the ACIs on Guantanamo Bay, a land area outside of the NSGB Exposure Units (EUs) and an area at the ACI Area (see Figure 5-3 in Appendix C). $PM_{2.5}$ (fine, inhalable particles with diameters that are 2.5 micrometers and smaller) exceeded NAAQS at all three locations. The NAAQS for PM_{10} (inhalable particles with diameters that are 10 micrometers and smaller) and NO_2 were exceeded at one location (on a land area outside of the NSGB EUs).

[4]CDC Fact Sheet [No Date Provided]. "What You Should Know about Formaldehyde." http://www.cdc.gov/nceh/ drywall/docs/ WhatYouShouldKnowaboutFormaldehyde.pdf. Last accessed: 1 Feb 2017.

Tap Water

The tap water source for Camp Justice is the NSGB Windward Desalination Water Treatment Plant (WTP). The water leaving the WTP is considered fit for human consumption (FFHC; Commander, Navy Installations Command [CNIC] 2013). Tap water samples were compared to the USEPA MCLs, which are regulatory standards required in the United States by the Safe Drinking Water Act. Only one chemical, Total Trihalomethanes (TTHM), collected from outside the Expeditionary Legal Complex (ELC) portable men's latrine, exceeded its MCL in one of 18 samples (the maximum detected concentration of TTHM was 81 µg/L and the MCL is 80 µg/L). Bottled water has always been provided for ingestion throughout Camp Justice. As required by Navy Policy, NSGB publishes their Annual Consumer Confidence Report for Drinking Water Quality online:

https://www.cnic.navy.mil/content/dam/cnic/cnrse/NSGuantanamoBay/CCR_2015V2.pdf.

Asbestos

The teams visual inspections of all spaces at Camp Justice determined that asbestos-containing material, identified in previous asbestos inventory surveys, was "non-friable" (not a hazard if undisturbed). Sampling for airborne asbestos in AV-29, AV-31, AV-32, and AV-34 were an order of magnitude (a factor of 10) below the OSHA PEL.

Ionizing Radiation

Based on its historical use as a hangar and the potential for ionizing radiation from avionics and non-destructive testing, radiological survey instruments, dosimeters, and detectors were used to measure ionizing radiation in Building AV-32. In addition, thermoluminescent dosimeters were placed in AV-29, AV-31, and AV-34 to quantitatively measure radiation, and radon detectors were placed in AV-29, AV-31, AV-32, and AV-34. Results indicated that it is not likely that an individual would receive any additional radiation dose above normal background radiation from the area occupied in the surrounding OMC trailers, tents, offices, and courtroom buildings located on Camp Justice.

OSHA PELs

Indoor air results for formaldehyde, mercury and asbestos, in work areas, were also compared to OSHA PELs which are regulatory standards for employee occupational exposures in the workplace and there were no exceedances of the PELs. See Appendix B (Overview of the Phase II Risk Screening Evaluation Approach) for further discussion on this approach and these regulatory standards.

Epidemiology Investigation Summary

NMCPHC was requested to conduct two separate reviews with response to the DOD IG complaint. The first review addressed the allegation that the number of observed cancers was related to assignment at Camp Justice. A copy of first review is included as Appendix E. The second review was included as part of this PHR, taking into account potential exposures at Camp Justice, and is included in Section 4 of this report.

NMCPHC follows the CDC guidelines for the investigation of suspected cancer clusters, which involve both gathering and reviewing information about site-specific occupational and environmental hazards and the process for performing an epidemiological investigation. A formal cancer cluster investigation is not supported at Camp Justice because the number and various types of cancer cases validated in this review did not meet the minimum criteria recommended by the CDC (CDC 2013).

Because a formal cancer cluster investigation was not supported by the guidelines, a case series analysis was conducted. The case series analysis consisted of a review of the available medical information and peer-reviewed cancer literature, which described the associated risk factors and latency for each confirmed cancer type.

Based on the types and number of cancers observed and the lack of recognized occupational and environmental risk factors, it is unlikely that an environmental or occupational exposure is associated with these cancers. The term “unlikely” means that the evidence is insufficient to connect the environmental and occupational conditions to the observed cancers. Current epidemiologic methods are not adequate to determine if there were other factors, like genetic errors or modifications, in these cases. See Section 4 (Epidemiology) of this report for further details and discussion.

This PHR was conducted with environmental data that were collected based on the historical use of Camp Justice and the potential exposures to site-specific chemicals anticipated to be present for both workers and residents. Even though signs of contamination were not evident during several site visits to Camp Justice, and there was no documentation to suggest the Camp was not safe, extensive samples were still collected for soil, water, indoor air, and outdoor air (to include the sampling and modeling of the NSGB ACIs) to ensure all potential pathways of exposure were evaluated. The results of the NSGB PHR indicated that current and future potential health risks related to environmental sources within Camp Justice and ACIs were primarily due to formaldehyde in the indoor air of modular buildings, not contamination from its former use as an airfield. Indoor air concentrations of formaldehyde were similar to concentrations frequently found in modular home building materials in the US. During development of this PHR, risk

management actions were taken and were demonstrated to be effective at reducing indoor air concentrations of formaldehyde in these modular buildings.

Lastly, review of the HHRA results (see Section 2 – Human Health Risk Assessment) of this report did not indicate any significant environmental exposures or an elevated human health risk due to environmental exposures.

Findings and Recommendations

See Section 7 (Camp Justice PHR Risk Management Recommendations) of this report for a complete list of findings and risk management recommendations. In addition, see Appendix F (NMCPHC Status of Previous Public Health Review Risk Management Recommendations, February 2017) for a full listing of recommendations and their status for this PHR to date. Below is a summary of the findings and recommendations of the PHR:

1. Camp Justice is unique as an Expeditionary Camp that is located on and surrounded by NSGB, a fixed naval installation with a fixed Military Treatment Facility. It is not clear, based on the manner in which occupational and environmental health (OEH) support services have and are being provided to date, if Camp Justice is a DoD Expeditionary Camp or a fixed naval installation. The current Interservice Support Agreement (ISSA) between NSGB and Joint Task Force Guantanamo (JTF GTMO) specifies compliance with both fixed installation and expeditionary requirements resulting in confusion and gaps in compliance at Camp Justice. If Camp Justice is an Expeditionary Camp, then DoD Expeditionary OEH program requirements apply.[5,6] If Camp Justice is a Fixed Installation, then fixed naval installation OEH requirements apply .[7,8,9] These requirements, and their intended populations, are significantly different.
2. Due to the uncertainty in the expeditionary versus fixed installation categorization, an Occupational and Environmental Health Site Assessment (OEHSA) was not completed

[5]Department of Defense Instructions (DoDI) 6490.03 (11 August 2006, Deployment Health; DoDI 6055.05 (11 November 2008, Occupational Environmental Health); Joint Chiefs of Staff Memorandum (2 November 2007, MGM 0028-07 Procedures for Deployment Health Surveillance; and DoD Dir 6490.02E (3 October 2013 – Comprehensive Health Surveillance).

[6]USSOUTHCOM Message of 5 October 2016 (Force Health Protection (FHP) Guidance for Deployment in USSOUTHCOM Area of Responsibility [AOR] as of 5 October 2016)

[7]OPNAVINST 5090.1D (10 Jan 2014, Environmental Readiness Program) and OPNAVINST 5100.23G (CH-1 - 21 Jul 2011 – Navy Safety and Occupational Health Program Manual).

[8]DoD 4715.05-G (1 May 2007, Overseas Environmental Baseline Guidance Document)

[9]Environmental Final Governing Standards Cuba October 2016 (cancels Final Governing Standards for Cuba of September 1994)

for Camp Justice prior to establishing the Camp as would have been required for an Expeditionary Camp. An OEHSA is a comprehensive, all-hazards assessment used to identify OEH threats at a deployment site (e.g., base camp or forward operating base). The purpose of the OEHSA is to identify and evaluate potential environmental exposures that may impact the health of deployed personnel prior to establishing the installation so appropriate risk management actions can be implemented. It is possible that if an OEHSA had been performed, this PHR effort may not have been required.

3. OMC has no environment, safety, or health professionals on staff and therefore are not able to determine and deconflict the varying interpretations of OEH support services they receive from JTF GTMO, NSGB, and US Naval Hospital Guantanamo (USNAVHOSP GTMO).
4. Asbestos Management Program (AMP) requirements are not fully implemented at NSGB which affects the ability of OMC to comply with those requirements (Naval Facilities Engineering Command Southeast [NAVFAC SE] 2017).
5. The ACIs at NSGB are not in compliance with the Overseas Environmental Baseline Guidance Document (OEBGD) and the Environmental Final Governing Standards (FGS) Cuba incinerator requirements.[8,9]
6. For Camp Justice, the lack of program compliance and full program implementation resulted in data gaps which required extensive resources for environmental testing to assess the level of health risk and to address the DoD IG investigation complaint.

Several of these programmatic deficiencies have been repeatedly identified in previous NAVFAC SE external oversight Environmental Management System (EMS) and Compliance Audit Reports.[10,11] NAVFAC is the lead Naval Systems Command (SYSCOM) for facilities and is responsible and accountable for executing CNIC environmental requirements. The US Navy's EMS is a formal management framework that provides a systematic means of reviewing and improving operations, creating awareness, and improving environmental performance. The US Navy's EMS employs a cycle of policy, planning, implementation and operation, evaluation, and corrective actions, including both internal and external management reviews at each and every level (Chief of Naval Operations [CNO] – Budget Submitting Office [BSO] – Region – Installation).

Another key finding is that for Department of the Navy (DoN), there is a lack of Bureau of Medicine and Surgery (BUMED) public health expertise input into the Environmental Program

[10]28 April – 02 May 2014 NAVFAC SE External Environmental Management System and Compliance Audit Report – Naval Station Guantanamo Bay

[11]6-11 November 2016 NAVFAC SE External Environmental Management System and Compliance Audit Report - Naval Station Guantanamo Bay

Objective Memorandum (POM) process when prioritizing environmental readiness levels (ERLs) and deciding on funding levels for environmental programs (e.g., AMP) to include throughout the execution year as program funding decisions are adjusted. This can result in creating potential exposures and health risks to workers, their families, and at times the general public. The result is non-medical personnel making decisions with potential health risk consequences. This could also be perceived as non-medical personnel making assumptions for health risks for others (workers, families) without their knowledge and consent. In addition to Camp Justice, other examples of where this has occurred in other environmental programs in the recent past includes the Sampling and Testing for Lead in Drinking Water in Priority Areas Program [LIPA] and the Navy's Radon Assessment and Mitigation Program (NAVRAMP).

Recommended Risk Management Actions

See Section 7 (Camp Justice Public Health Review Risk Management Recommendations) of this report for a complete list and discussion of risk management recommendations. Below is a summary of the risk management actions identified in the PHR. As previously discussed, the results of the NSGB PHR indicated that current and future potential health risks related to environmental sources within Camp Justice and ACIs were primarily due to formaldehyde in the indoor air of modular buildings, not contamination from its former use as an airfield. This finding, and others, are largely a result of deficiencies in current processes (environmental program funding priorities), programs (AMP), and oversight. Therefore, these risk management recommendations address the causes, not the symptoms, of the problems identified during the course of the PHR (July 2015 to February 2017).

Formaldehyde in Modular Buildings (OMC)

Until such time the modular buildings are replaced with no or low emission formaldehyde containing materials, recommend engineering/institutional controls be implemented to include:

- Develop a standard operating procedure (SOP) for documenting the interim engineering control actions such as inspecting, repairing and replacing Heating, Ventilation, and Air Conditioning (HVAC) systems.
- Evaluate and monitor the capacity of the existing air handling (and dehumidifying) equipment in the modular units (e.g., Cuzcos) to ensure they are providing adequate ambient air flow while maintaining acceptable temperature (< 72 degree Fahrenheit) and humidity (< 60%).
- Until modular buildings are replaced, consider sampling formaldehyde annually during the summer to verify and demonstrate that engineering controls are effective at keeping formaldehyde levels at their current reduced levels.

Polycyclic Aromatic Hydrocarbons (PAHs) in Soil Proximate to AV-34 (OMC)

If intrusive activities (planned or yet unknown) occur that disturb soil in those locations proximate to Building AV-34, a Soil Management Plan (SMP) should be developed to minimize contact with impacted soils and generation of airborne concentrations of benzo(a)pyrene to occupants of AV-34 and workers performing the activities.

Mercury in Building AV-29 (OMC):

Building AV-29 was formerly a dental clinic and mercury was detected in indoor air at the floor level (not the breathing zone) which indicates that mercury is likely present in the cracks/crevices between the floor tiles and in the sub-flooring materials. Therefore, if intrusive activities (planned or yet unknown) occur that may disturb floor tiles/flooring/plumbing/piping (e.g., remodeling) inside Building AV-29, then appropriate measures should be implemented to ensure the health and safety of occupants of Building AV-29 and workers performing the activities. For example, a mercury materials management plan and mercury sampling plan (including collecting indoor air samples) should be developed to minimize generation of airborne mercury.

Camp Justice PHR Documentation (NSGB)

Continue to maintain the Guantanamo Bay PHR website.[12]

Administrative Record (CNIC)

Create a Camp Justice PHR Administrative Record website on the CNIC Portal. Work with the DoN, Director of Records to ensure the most appropriate standard subject identification code (SSIC) is assigned for the final disposition and records retention period. It is likely these records will require retention to span the amount of time DoN will remain at NSGB.

Asbestos Management Program (NSGB, USNAVHOSP GTMO)

The AMP is not fully implemented at NSGB. This affects the ability of the tenant commands on Camp Justice to comply with their responsibilities under this program. Recently, NSGB signed out a new installation instruction for managing asbestos, applicable to all NSGB department and tenant commands (NSGBINST 5090.8 – 2 February 2017 – Asbestos Program Management). As soon as possible, NSGB should fund and implement recommendations as identified in the NAVFAC SE 5 January 2017 Naval Station Guantanamo Bay (NSGB) Asbestos Management Program Review Report. US Naval Hospital Guantanamo Bay (USNAVHOSP GTMO) continue to

[12]https://cnic.navy.mil/regions/cnrse/installations/ns_guantanamo_bay/om/environmental_support/Guantanamo_Bay_PHR.html.

maintain laboratory capabilities for asbestos identification and quantification using polarized light microscopy (PLM) and phase contrast microscopy (PCM) as required.

Public Health Expertise (DoN, OMC, SOUTHCOM/JTF GTMO)

For program funding and execution of EOH programs at fixed naval installations and expeditionary camps, determine and obtain resources required to support applicable environmental and occupational programmatic requirements. DoN ensure public health subject matter experts (e.g., BUMED) are integrated into the Resource Sponsor (Office of the Chief of Naval Operations [OPNAV] N45), BSO, region, and installation decision making process when funding reductions in environmental programs (e.g., AMP) could result in the potential for increased health risks, in the POM workup or at any time during the execution year.

Occupational and Environmental Health Site Assessment – (OMC, SOUTHCOM/JTF GTMO, CNRSE/NSGB and NAVMEDEAST/USNAVHOSP GTMO)

Determine which environment, occupational health, and safety standards apply at Camp Justice and how those services will be provided to fill the gaps in coverage to ensure continuous coverage into the future. SOUTHCOM/JTF GTMO (per DoD 6490.03 [Deployment Health]), should submit the NMCPHC Final Public Health Review Report as an OEH Exposure Incident Report (IR) to the Defense Occupational and Environmental Health Readiness System - Industrial Hygiene (DOEHRS-IH) to satisfy the OEHSA requirement.

Environment, Safety, and Health Professional (OMC)

Consider establishing an environment, safety, and health position at headquarters to oversee, determine, and deconflict support services OMC receives from JTF GTMO, NSGB and USNAVHOSP GTMO.

Table of Contents

Tables

Figures

Appendices

List of Acronyms

Acronym	Definition
474th ECES	474th Expeditionary Civil Engineering Squadron
ACI	Air Curtain Incinerator
ALM	Adult Lead Methodology
AMP	Asbestos Management Program
AOR	Area of Responsibility
ATSDR	Agency for Toxic Substances and Disease Registry
BEEF	Base Engineer Emergency Force
BES	Budget Estimate Submission
BSO	Budget Submitting Office
BUMED	Bureau of Medicine and Surgery
CDC	Centers for Disease Control and Prevention
CLO	Commissions Liaison Office
CNIC	Commander, Navy Installations Command
CNO	Chief of Naval Operations
CNRSE	Commander Navy Region Southeast
CONUS	Continental United States
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
CSG	Commissions Support Group
CSM	Conceptual Site Model
DoD	Department of Defense
DoD IG	Department of Defense Inspector General
DoDI	Department of Defense Instructions
DOE	Department of Energy
DOEHRS-IH	Defense Occupational and Environmental Health Readiness System – Industrial Hygiene
DON	Department of Navy
DON IG	Department of the Navy Inspector General
EDC	EpiData Center
ELC	Expeditionary Legal Complex
EMS	Environmental Management System

Acronym	Definition
ERL	Environmental Readiness Level
EU	Exposure Unit
FFHC	Fit For Human Consumption
FGS	Final Governing Standards
FHP	Force Health Protection
GAO	Government Accountability Office
GTMO	Guantanamo
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HVAC	Heating, Ventilation, and Air Conditioning
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
IEUBK	Integrated Exposure Uptake Biokinetic
IG	Inspector General
IR	Incident Report
IRIS	Integrated Risk Information System
ISO	International Standards Organization
ISSA	Interservice Support Agreement
IUR	Inhalation Unit Risk
JTF	Joint Task Force
LIPA	Lead in Drinking Water in Priority Areas
LNT	Linear No Threshold
MCL	Maximum Contaminant Level
MCSFCO	Marine Corps Security Force Company
MILCON	Military Construction
MPOI	Maximum Point of Impingement
mrem	millirem
MRL	Minimum Risk Level
MSW	Municipal Solid Waste
MWC	Municipal Waste Combustion
NAAQS	National Ambient Air Quality Standards

Acronym	Definition
NAVFAC	Naval Facilities Engineering Command
NAVFAC SE	Naval Facilities Engineering Command Southeast
NAVINSGEN	Office of the Naval Inspector General
NAVMEDEAST	Navy Medicine East
NAVRAMP	Navy's Radon Assessment and Mitigation Program
NCRP	National Council on Radiation Protection and Measurements
NGIS	Navy Gateway Inns and Suites
NIOSH	National Institute of Occupational Safety and Health
NMCPHC	Navy and Marine Corps Public Health Center
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NOV	Notice of Violation
NRC	Nuclear Regulatory Commission
NSGB	Naval Station Guantanamo Bay
OCONUS	Outside of the Continental United States
OEBGD	Overseas Environmental Baseline Guidance Document
OEH	Occupational and Environmental Health
OEHHA	Office of Environmental Health Hazard Assessment
OEHSA	Occupational and Environmental Health Site Assessment
OMC	Office of Military Commissions
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Office of the Chief of Naval Operations Instructions
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste Emergency Response
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCM	Phase Contrast Microscopy
PEL	Permissible Exposure Limit
PHR	Public Health Review
PLM	Polarized Light Microscopy
PM	Particulate Matter
POA&M	Plan of Action and Milestones
POM	Program Objective Memorandum

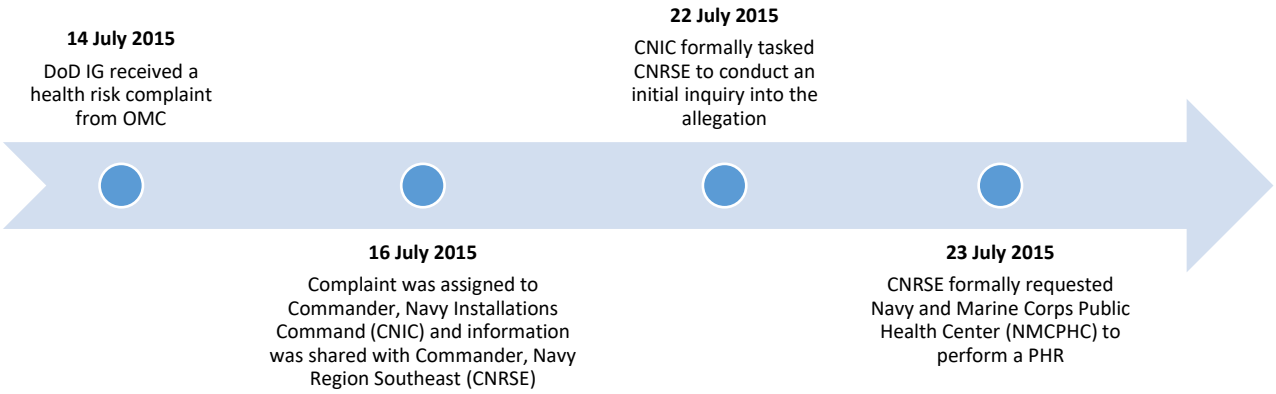
Acronym	Definition
ppb	Part per billion
PPRTV	Provisional Peer Reviewed Toxicity Values
REL	Reference Exposure Level
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SL	Screening Level
SMP	Soil Management Plan
SOP	Standard Operating Procedure
SSIC	Standard Subject Identification Code
STSC	Superfund Technical Support Center
SVOC	Semi-Volatile Organic Compounds
SYSCOM	Systems Command
TAD	Temporary Additional Duty
TNRC	The National Research Council
TLD	Thermoluminescent Dosimeter
TPH	Total Petroleum Hydrocarbon
TTHM	Total Trihalomethanes
UCL	Upper Confidence Level
US	United States
USAF	United States Air Force
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USEPA Combustor Protocol	USEPA HHRA Protocol for Hazardous Waste Combustion Facilities
USN	United States Navy
USNAVHOSP	United States Naval Hospital
USNH	United States Naval Hospital
USPSTF	United States Preventative Services Task Force
USSOUTHCOM	United States Southern Command
WHO	World Health Organization
WTP	Water Treatment Plant

Section 1: Introduction

This Public Health Review (PHR) was conducted in response to a Department of Defense (DoD) Inspector General (IG) hotline health risk complaint from the Office of Military Commissions (OMC) for Camp Justice, which is located on Naval Station Guantanamo Bay (NSGB; see Figure 1-1). The hotline complaint alleged that:

- Since 2004, military and civilian members working for OMC have been exposed to carcinogens in an area surrounding the Commissions' trailers, tents, offices and courtrooms;
- The area may have been a dumping ground for fuel in the past; and
- The old Commissions' building potentially contains asbestos and possibly other carcinogens and the new Commissions' building was built on the old runway and could be contaminated (see Figure 1-2).

PHR investigations are complex and time-intensive, and typically comprise iterative steps because most environmental contaminants (e.g., radon and mercury) in outdoor air, indoor air, drinking water, and soil are not apparent, detectable, and certainly not quantifiable to the human senses.



Purpose

The purpose of this PHR is to respond to the 14 July 2015 DoD IG hotline complaint. The PHR consisted of conducting site visits, reviewing available historical occupational health and environmental data, assessing data gaps, collecting information to fill data gaps, conducting a human health risk assessment (HHRA) using the collected data, conducting an epidemiological study, and making risk management recommendations. This report summarizes the actions taken at Camp Justice between August 2015 and February 2017 to address the complaint.

This PHR took very conservative, health-protective, and comprehensive steps to investigate the potential health concerns at Camp Justice. Risk management actions were taken where needed. A significant amount of investigative work was conducted in a very limited amount of time.

PHR Framework

The United States Environmental Protection Agency (USEPA) Superfund HHRA process was used as the framework for the PHR to conduct the risk assessment, similar to being in the United States (US). The HHRA was conducted by identifying groups or subgroups at risk, chemicals of potential concern (COPCs), health effects or toxicity of the COPCs, how exposures occur (i.e., complete pathways [air, water, soil]), exposure routes (inhalation, ingestion, dermal contact), and calculating quantitative cancer and noncancer risks for all chemicals, all pathways, and all exposure scenarios.

The questions a PHR tries to answer include:

- What chemicals have been released to the environment?
- How much of the chemicals are present and in what location?
- How might people come into contact with the chemicals?
- How might exposure to these chemicals affect people's health?
- What actions are needed to protect public health?

A PHR relies upon:

- **Environmental data –** Levels of chemicals and microorganisms (bacteria) in various media (soil, soil gas, water, air, and food).
- **Exposure data –** How people could come into contact with chemicals and microorganisms.
- **Toxicity data –** What adverse health effects might be expected due to chemical exposure.
- **Epidemiological health outcome data –** Information on community-wide rates of illness, disease, and death.
- **Community health concerns –** United States Navy (USN) personnel's reports on disease and illness.

Multiple lines and sources of evidence were evaluated to support the recommendations and conclusions of this report.

Site Visits	Technical Reports
4-8 August 2015	- 21 August 2015 NMCPHC Public Health Review Report for Camp Justice (Appendix G; NMCPHC 2015)
25-29 September 2015	- 29 October 2015 Resolution Consultants Indoor Air Quality Assessment Report (Appendix I; Resolution Consultants 2015) - 23 February 2016 NMCPHC Preliminary Public Health Screening Risk Assessment Report for Camp Justice (Appendix H; NMCPHC 2016b)
11 -14 September 2015	- 7 April 2016 Resolution Consultants Overseas Baseline Environmental Assessment Report (Appendix J; Resolution Consultants 2016b)
15 – 30 April 2016	- 11 April 2016 Resolution Consultants Environmental Investigation Report (Appendix K; Resolution Consultants 2016a)

Site Visits	Technical Reports
	- 6 May 2016 Resolution Consultants Supplemental Environmental Investigation for the Formaldehyde Sampling Results (Appendix L) - 24 May 2016 Resolution Consultants Supplemental Environmental Investigation for the Mercury, Analysis for Background PAHs in Soil, and PCBs Sampling (Appendix M) - 18-30 April 2016 AASI Air Curtain Incinerator Test Report for NS Guantanamo Bay (Appendix D) - 6 February 2017 NMCPHC Final Public Health Review Report

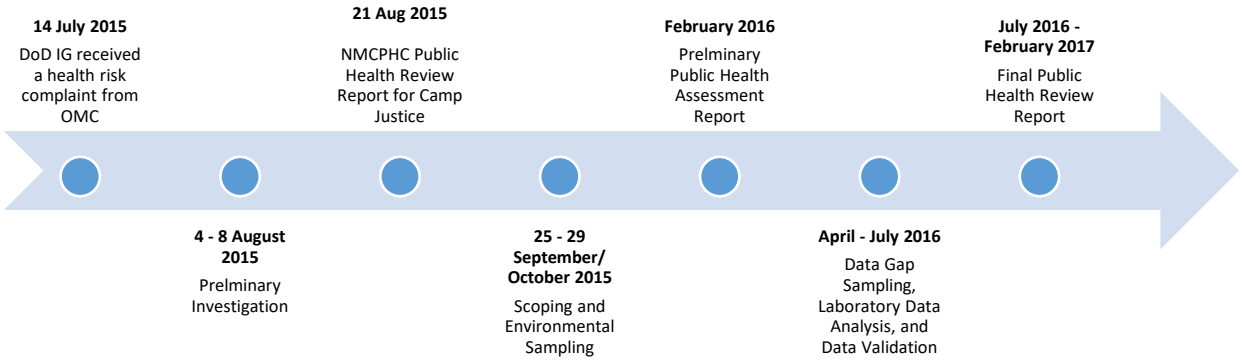
Overview of the Setting at Camp Justice

Camp Justice was established at NSGB by the 474th Expeditionary Civil Engineering Squadron (474th ECES). The camp, which is located on the windward side of NSGB at the former McCalla Airfield, includes the Expeditionary Legal Complex (ELC) and supports the OMC (see Figure 1-3).

The first phase of construction began in July 2007 and included the installation of the lodging facilities and utility infrastructure. The second phase of construction began in September 2007 and included ELC construction and ongoing improvements to the cantonment and life support areas of Camp Justice. The camp was completed and met the design requirements in January 2008 and is currently managed by the United States Air Force (USAF) Base Engineer Emergency Force (BEEF).

Investigation Chronology

The investigation chronology is summarized below. For a full description and timeline of the actions taken to date, see Appendix A. Through each step of this PHR, even though there were no immediate health concerns identified, a conservative, health-protective approach was taken. We continually asked the question "Do we need to take further action to protect human health based on these results?" In some cases the answers to this question lead to additional evaluation, re-sampling, and risk management actions, all of which were integrated into this Final PHR Report.



4-8 August 2015 Preliminary Investigation

NMCPHC sent a team of public health experts to NSGB 4-8 August 2015 to conduct a preliminary investigation. The preliminary investigation included performing an industrial hygiene and habitability survey of the OMC buildings, tents, and trailers at Camp Justice. Based on a review of available documents and a walk-through survey, it was determined, in concurrence with the 2013 NMCPHC Habitability Assessment Report, that the OMC buildings, tents, and trailers where people live and work were habitable. The administrative worksites were low hazard and had little potential for overexposures to current occupational health standards. Therefore, based on these industrial hygiene findings, it was determined that none of the OMC personnel working in these buildings were required to be enrolled in occupational medical surveillance or required occupational certification examinations.

Although the OMC buildings, tents, and trailers at Camp Justice were deemed habitable, environmental records for Camp Justice were limited. Additionally, historical information regarding former operations onsite (e.g., hangar maintenance and flight-line activities) and/or potential spills or releases to the environment (e.g., fuel tanks, and use, storage, and disposal of solvents from work processes) was limited. To reduce uncertainty associated with limited environmental records and historical information for Camp Justice, NMCPHC identified environmental data gaps and recommended additional environmental sampling be performed at Camp Justice to appropriately address the DoD IG complaint and allow the epidemiological

investigation to be completed. NMCPHC prepared the Public Health Review Report for Camp Justice on 21 August 2015, which is included with this report as Appendix G (NMCPHC 2015).

25-29 September 2015/October 2015 Scoping and Environmental Sampling

Following completion of the first NMCPHC report (Appendix G; NMCPHC 2015), CNRSE (with Resolution Consultants) and NMCPHC (with PIONEER Technologies Corporation) conducted a site visit to Camp Justice to further develop the environmental investigation and sampling plan. Subsequent to this site visit, CNRSE (with Resolution Consultants) conducted an environmental investigation and Overseas Baseline Environmental Assessment on 9-16 October 2015 which included the collection and analysis of indoor air, water, and soil samples, and the development of several other environmental reports (see Appendices J, K, L, and M).

February 2016 Preliminary Public Health Assessment Report

In February 2016, once the results from the September and October 2015 site visits were available, NMCPHC issued its second report (Appendix H; NMCPHC 2016b). The purpose of this preliminary public health screening risk assessment was to determine any risk management actions that needed to be taken, at that time, to protect human health. This preliminary report compared sampling data from the CNRSE Environmental Investigation Report (Appendix K) for COPCs in soil and indoor air to health-protective USEPA screening levels (SLs), adjusted to reflect site-specific exposures at Camp Justice.

Mercury and formaldehyde concentrations in indoor air (in modular buildings) and arsenic and benzo(a)pyrene concentrations in soil exceeded SLs; therefore, further evaluation or risk management actions were recommended for these chemicals. Findings were that the vast majority of COPC concentrations detected at Camp Justice were less than their respective USEPA SLs and formaldehyde and mercury concentrations in air were below their respective Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) for employee occupational exposure in the workplace. However, this one-on-one comparison of COPCs with OSHA PELs did not take into consideration cumulative risks related to multiple constituents and pathways of exposure. The additional evaluations or recommended risk management actions presented in the Preliminary Public Health Screening Risk Assessment (Appendix H; NMCPHC 2016b) are summarized below:

- **Formaldehyde in Indoor Air (modular structures)** – Evaluate the heating, ventilation, and air conditioning (HVAC) capacity of the existing air handling equipment to provide additional ambient air flow while maintaining acceptable temperature and humidity levels under maximal expected loads. In the future, recommend replacement or purchase of new modular buildings constructed with no, or low emission formaldehyde containing materials.

- **Mercury in Indoor Air (Building AV-29)** – Collect indoor air samples for mercury using National Institute of Occupational Safety and Health (NIOSH) Method 6009 (Modified per Standard Operating Procedure [SOP] 1827) to determine if mercury in the breathing zone is of concern. Screening data indicated that mercury concentrations for indoor air exceeded SLs. However, these data were not representative of, and are anticipated to be much greater than actual occupational exposure concentrations in the breathing zone.
- **Arsenic in Soil** - Analyze background samples for arsenic to determine what the naturally occurring concentrations of arsenic in soil are proximate to Camp Justice. Soil data indicated that there are locations throughout Camp Justice with arsenic concentrations that exceed SLs. However, arsenic concentrations in soil can be naturally occurring and/or can be enriched by human activities (e.g., applying arsenic based herbicides/pesticides).
- **Benzo(a)pyrene in Soil Proximate to Building AV-34** - Perform additional site reconnaissance at Building AV-34 to determine if additional soil samples should be collected, which will inform the need for any further risk management actions. The highest concentrations of benzo(a)pyrene were detected in soil proximate to Building AV-34.

The 23 February 2016 NMCPHC Preliminary Public Health Screening Risk Assessment indicated that CNRSE and NMCPHC would develop the work plan for conducting sampling and analysis of air curtain incinerator (ACI) emissions. ACI sampling results were used in the final health risk assessment. The overall aim of the work plan was to characterize potential exposures from these incinerators which are not on Camp Justice (see Figure 1-4).

April 2016 Data Gap Sampling

CNRSE and NMCPHC returned to Camp Justice and the following sampling was conducted:

- Formaldehyde in modular buildings was re-sampled after risk management actions (HVAC modifications) were implemented. The results showed a significant reduction (63% decrease in the average concentration) in formaldehyde levels.
- Mercury in the indoor air of Building AV-29 was resampled at the appropriate breathing zone level. Mercury was not detected in any of the samples (detection limit is less than the USEPA SLs).
- Background arsenic samples in soil were analyzed and found to be comparable to naturally occurring levels found in the US.
- Additional sampling for benzo(a)pyrene in soil around the two locations proximate to AV-34 was conducted. All soil concentrations (i.e., initial sampling [October 2015] and re-sampling [April 2016]) were similar to concentrations typically found in urban areas in the US.

- Emissions from the ACIs were sampled so that the data could be modeled for air dispersion and deposition in soil throughout NSGB, including Camp Justice (see Appendix Q).

July 2016 – February 2017 Final Public Health Review Report

The measured soil, air, and tap water data and the ACI emissions data (modeled air dispersion and soil deposition) collected in October 2015 and April 2016, and information from the 21 February 2016 Preliminary Public Health Screening Risk Assessment Report were evaluated to calculate cumulative cancer risks and/or noncancer hazard indices (HIs) for all COPCs and all exposure pathways (e.g., inhalation of indoor air, inhalation of outdoor air, ingestion of soil, and dermal contact with soil). See Section 2 (Human Health Risk Assessment) of this report for a full discussion.

While the environmental investigation was conducted, an epidemiological case series analysis was performed. In the epidemiological case study, medical literature was reviewed to determine known environmental risk factors for each confirmed cancer type, and medical databases were reviewed to confirm the diagnosis of cancer and cancer types for the OMC active duty personnel who lived or worked at Camp Justice. For further discussion on this epidemiological investigation, see Section 3 (see Appendix E; NMCPHC 2016a).

Demographics for Personnel Who Live and/or Work in Camp Justice

Camp Justice has the capacity to house up to (b) personnel billeted and assigned to the OMC, security guards, journalists, and logistics, operations, and maintenance staff. Camp Justice and the ELC are comprised of 150 structures, including a courthouse, 15 administrative support facilities, and an expeditionary lodging facility (tent city).

Camp Justice is located within NSGB, on the southeast corner of Cuba at the entrance of the Guantanamo Bay (see Figure 1-4). The NSGB complex consists of the windward and leeward sides and comprises 45 square miles.

The land portion of NSGB is enclosed by a wire perimeter fence patrolled by the US Marine Corps Security Force Company – Guantanamo Bay (MCSFCO). NSGB is the hub of US military operations in the Caribbean Theater of Operations and provides logistics support to the USN, United States Coast Guard (USCG), authorized air operations and the Joint Task Force Guantanamo (JTF GTMO). NSGB is populated by nearly 6,000 US service members, DoD and other government civilian employees, contract employees (from several countries), and family members of all groups.

Major tenant commands include: OMC, JTF GTMO, US Naval Hospital Guantanamo (USNAVHOSP GTMO), MCSFCO, Personnel Support Activity, Naval Atlantic Meteorology and Oceanography Command Detachment, Department of Defense Education Activity, International Organization

for Migration, Naval Media Center Detachment, NAVFAC SE – Public Works Detachment, and USCG Aviation Detachment.

Demographics

JTF GTMO is a US military JTF under US Southern Command (SOUTHCOM), located on the southeastern end of the NSGB (see Figure 1-1). (b) (3) (B) [redacted]

NSGB and JTF GTMO Demographics

NS	Type	JTF
(b)	Military	(b)
(b)	Civil Service	(
(b)	Contractor	(b
(b)	Spouses (non-working)	(b
(b)	Children (non-working)	(b
(b)	Other Residents (Third-Country Nationals)	(b
(b)	**Total**	(b)

The OMC has facilities located at Camp Justice. From 2008 to present, the number of personnel supporting the OMC has varied from (b) (3) (B) staff members, and those staff members are considered permanent party working in Buildings (b) (3) (B) . Most of the OMC personnel work in Building (b) (3) (see Figure 1-2). Additional information regarding specific personnel at NSGB as a result of supporting OMC is included in the following in-text table.

OMC – Camp Justice

Expeditionary Facilities	Construction Date
Camp Justice Berthing Tents	Constructed 2005 by JTF BEEF
(b) (3) (B) [redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Air Force BEEF

Between (b) and (b) BEEF personnel work in tents in Camp Justice. Until 2011, BEEF personnel berthed in Camp Justice tents; however, now berthing is in unaccompanied housing facilities at NSGB.

Commissions Liaison Office

The Commissions Liaison Office (CLO), formerly the Commissions Support Group (CSG), is comprised of Navy and Army military staff members who are on nine-month rotations. While the current number of CLO staff at NSGB is (b , as many as (b CLO staff have been at NSGB at one time in the past. CLO staff primarily work in Building (b) (3) and berth in unaccompanied housing facilities at NSGB.

Transient Personnel (During Commissions)

The OMC presence at NSGB has increased since 2008. One hundred and eleven (b) civilian positions have a 30% turnover rate. Additionally, approximately (b) contractors have worked for OMC since 2008. When commissions are in progress, personnel are allowed to sleep in soft shelter tents or rigid-walled shelters (also known as Cuzcos) in Camp Justice or reside in Navy Gateway Inns and Suites (NGIS) lodging.

During commissions, media and non-governmental personnel observe the hearings. Over the years, it is estimated that 1,000 people have stayed at Camp Justice for one week or visited regularly (e.g., media). These people have slept in Camp Justice tents, and often worked in AV-32 or observed hearings in the courtroom. When commissions are in progress, supporting personnel berth at Camp Justice for short durations (1-2 weeks; 2 to 4 times per year).

Report Organization

This report summarizes the results of multiple, detailed evaluations which are included as appendices to this report. The main text of this report is organized as follows:

- Section 1: Introduction
- Section 2: Human Health Risk Assessment
- Section 3: Ionizing Radiation
- Section 4: Epidemiology
- Section 5: Summary of PHR Findings Relative to the Original DoD IG Hotline Complaint
- Section 6: Public Health Summary Conclusions
- Section 7: Camp Justice PHR Risk Management Recommendations
- Section 8: References

Section 2: Human Health Risk Assessment

This section summarizes the results of the HHRA which is presented in Appendix C (Naval Station Guantanamo Bay Human Health Risk Assessment for Camp Justice February 2017) of this report. The purpose of the HHRA was to characterize current and future potential health risks related to sources within Camp Justice and ACIs, which are used to burn municipal solid waste (MSW) generated at NSGB. The impact of the ACIs on receptors (service members, DoD and other government civilian employees, contract employees, and family members) living at NSGB was also assessed because emissions from the ACIs could potentially impact locations at Camp Justice and throughout NSGB.

Methodology

Risk assessment is an established scientific approach used to evaluate the potential for impacts to human health and the environment associated with exposure to chemicals in contaminated media (e.g., soil, water, air). Risk assessment is a management decision tool; risk assessment does not provide absolute statements about health and environmental impacts, and typically focuses on chemicals and exposure pathways (e.g., inhalation, ingestion, and dermal contact) directly related to a site. These assessments generally do not address risks from other sources of exposure (e.g., dietary exposures unless associated with food that might be contaminated from the site of concern, heredity, lifestyle), or risks from other chemicals that are not associated with the site under evaluation. Risk managers use the results of risk assessments to assist in determining if a site, or a portion thereof, requires further investigation or action (e.g., mitigation and remediation).

This risk assessment was performed in accordance with:

- USEPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA Combustor Protocol; USEPA 2005);
- US Navy Human Health Risk Assessment Guidance (PIONEER 2008); and
- USEPA Risk Assessment Guidance for Superfund (USEPA 1989).

The HHRA process is comprised of the following steps:

- **Data Evaluation and Reduction**. In this step, COPCs in soil, indoor air, outdoor air, and tap water inside of Camp Justice and the amount of the COPCs emitted from the ACIs were identified, and air concentrations and the amount of wet and dry deposition at receptor locations were predicted.

- **Exposure Assessment**. In this step, potentially exposed populations (i.e., receptors), exposure scenarios, complete exposure pathways, and exposure factors were identified.
- **Toxicity Assessment**. In this step, toxicity values for the COPCs identified in Step 1 were identified. Toxicity values include carcinogenic slope factors (CSFs; where applicable) and noncarcinogenic reference doses (RfDs) and/or reference concentrations (RfCs), where applicable.
- **Risk Characterization**. In this step, health risks associated with exposure to the COPCs were calculated using the information developed in Steps 1 through 3.

Summary of the HHRA

In this HHRA, data from the Preliminary Public Health Screening Risk Assessment (Appendix H; NMCPHC 2016b) and additional data collected based on the results of that risk assessment (April 2016) were used to calculate cumulative cancer risks and/or noncancer hazard indices for all COPCs and all pathways (e.g., inhalation of indoor air, inhalation of outdoor air, ingestion of soil, dermal contact with soil) of exposure. Exposure units (EUs) were defined to evaluate potential risks to receptors (population groups) based on where they live and/or work inside Camp Justice and outside of Camp Justice. In addition, the two areas (Inside Camp Justice and Outside Camp Justice) were conceptually divided into EUs to evaluate potential risks based on where various population groups live and work. Inside Camp Justice was divided into eight EUs (see Figure 2-1); Outside Camp Justice was divided into EUs based on land use (commercial/industrial, residential, and mixed use [a combination of commercial/industrial and residential]; see Figure 2-2). However, not all residential and commercial EUs were used to characterize risk. For the ACIs, maximum points of impingement (MPOIs; i.e., the highest dispersion and deposition points) in the residential and commercial EUs were evaluated to calculate cancer risks and noncancer hazards.

EU	Building(s)	Description
1	Old Cuzcos	EU-1 is located in the northern portion of Camp Justice (see Figure 2-1). This EU is comprised of paved and grassed surfaces and old Cuzcos (modular buildings with one bedroom and a shared bathroom adjoining the buildings). (b) (3) (B) [redacted]
2	New Cuzcos	EU-2 is located in the northwestern portion of Camp Justice (see Figure 2-1). This EU is comprised of paved and grassed surfaces and new Cuzcos (modular buildings with one bedroom and a shared bathroom adjoining the buildings). (b) (3) (B) [redacted]
3	ELC and Modular Buildings	EU-3 is located in the northern portion of Camp Justice (see Figure 2-1). This EU is comprised of primarily paved and some grassed surfaces and modular buildings. (b) (3) (B) [redacted]

EU	Building(s)	Description
4	AV-34	EU-4 is located in the northeastern portion of Camp Justice (see Figure 2-1). This EU is comprised of primarily grassed and some paved surfaces and a stick-frame permanent building (AV-34). (b) (3) (B)
5	AV-31	EU-5 is located in the eastern portion of Camp Justice (see Figure 2-1). This EU is comprised of primarily grassed and some paved surfaces and a concrete building (AV-31). (b) (3) (B) .
6	AV-32 and Modular Buildings	EU-6 is located in the southern portion of Camp Justice (see Figure 2-1). This EU is comprised of primarily paved and some grassed surfaces and a hangar (AV-32). Three modular buildings are located within the hangar and multiple modular buildings are located outside of the hangar. (b) (3) (B)
7	Tents	EU-7 is located in the southwestern portion of Camp Justice (see Figure 2-1). This EU is comprised of paved and grassed surfaces and tents. The tents, which have wood floors and are air conditioned, (b) (3) (B)
8	AV-29 and Modular Buildings	EU-8 is located in the southeastern portion of Camp Justice (see Figure 2-1). This EU is comprised of primarily grassed and some paved surfaces and a permanent building (AV-29) with a modular building next to it. (b) (3) (B)

Data Evaluation and Reduction Summary

Two sources of data were used in this HHRA:

- Measured soil, air, and tap water data collected in October 2015 and April 2016 Inside Camp Justice (see the Measured [Sampled] Data table below); and
- Modeled data from air dispersion and deposition modeling of ACI emissions.

Building Location	EU	Laboratory Measured (Sampled) Data								
		Outdoor Air Summa Canisters	Indoor Air Summa Canisters	Indoor Air (Formaldehyde)	Indoor Air (Mercury)	Indoor Air (Asbestos)	Tap Water	Paint Chips	Radon	Soil
Old Cuzcos	1	0	0	8	0	0	5	0	0	4
New Cuzcos	2	0	0	8	0	0	4	0	0	5
ELCs	3	0	6	8	0	0	1	0	0	7
AV-34	4	0	5	0	0	4	2	0	2	14
AV-31	5	0	1	0	0	1	0	0	1	7
AV-32	6	0	4	3	0	3	2	3	1	5
Tents	7	0	14	0	0	0	2	0	0	21
AV-29	8	0	0	1	19	5	2	0	2	6
Outdoor Air Background Samples	n/a	2	0	0	0	0	0	0	0	0

Building Location	EU	Laboratory Measured (Sampled) Data								
		Outdoor Air Summa Canisters	Indoor Air Summa Canisters	Indoor Air (Formaldehyde)	Indoor Air (Mercury)	Indoor Air (Asbestos)	Tap Water	Paint Chips	Radon	Soil
Soil Background Samples (Metals)	n/a	0	0	0	0	0	0	0	0	14
Total		**2**	**32**	**28**	**19**	**13**	**18**	**3**	**6**	**83**

Note:
The data presented in this table include October 2015 and April 2016 samples.

COPCs were identified by medium by comparing measured maximum detected concentrations in soil, outdoor air, and indoor air to one-tenth of the USEPA default 26-year residential regional screening levels (RSLs), which correspond to a cancer risk of 1E-07 and noncancer hazard quotient (HQ) of 0.1 using generic, risk-adverse, exposure assumptions (USEPA 2016). See Appendix R for a list of the sampled chemicals. The COPCs for Camp Justice (based on measured data only) are presented by medium below:

Media	Measured Data COPC			
Soil	2,4-Dinitrotoluene 2,6-Dinitrotoluene Aluminum Antimony (metallic) Arsenic, Inorganic Benz[a]anthracene Benzo[a]pyrene	Benzo[b]fluoranthene Benzo[k]fluoranthene Chlordecone (Kepone) Chrysene Cobalt Dichlorodiphenyldichloroethylene Dichlorodiphenyltrichloroethane	Dibenz[a,h]anthracene Dieldrin Indeno[1,2,3-cd]pyrene Iron Lead and Compounds Mercury (elemental) Naphthalene	Nickel Soluble Salts p-Chloroaniline Thallium (Soluble Salts) Total Carcinogenic Polycyclic aromatic hydrocarbon (PAH) (Benzo[a]pyrene toxic equivalence)
Indoor Air	1,2-Dichloroethane 1,3-Butadiene 1,4-Dioxane Benzene	Bromodichloromethane Bromoform Carbon Tetrachloride Chloroform	Ethylbenzene Formaldehyde Isopropanol	Mercury (elemental) Trichloroethylene Vinyl Chloride
Outdoor Air	1,2-Dichloroethane	Benzene	Carbon Tetrachloride	Chloroform

No COPCs were identified for tap water. One chemical concentration slightly exceeded the maximum contaminant level (MCL) in a portable men's latrine (total trihalomethanes were detected at 81 µg/L, [the MCL is 80 µg/L] in one of 18 tap water samples). Bottled water is used for consumption throughout Camp Justice.

Modeled air concentrations and deposition rates were calculated to account for chemicals detected in emissions from the ACIs (e.g., dioxins) and to predict current and future risks from

the ACIs.[13] The COPCs identified for the ACIs include all chemicals detected in emissions testing. The COPCs emitted from the ACIs fall into several categories and are listed in the table below. Some COPCs are simple gases (e.g., nitrogen oxides [NO_X], sulfur dioxide, carbon monoxide). Some COPCs exist in particulate form, or may initially be gases and then condense onto other particles or attach to particles in the atmosphere.

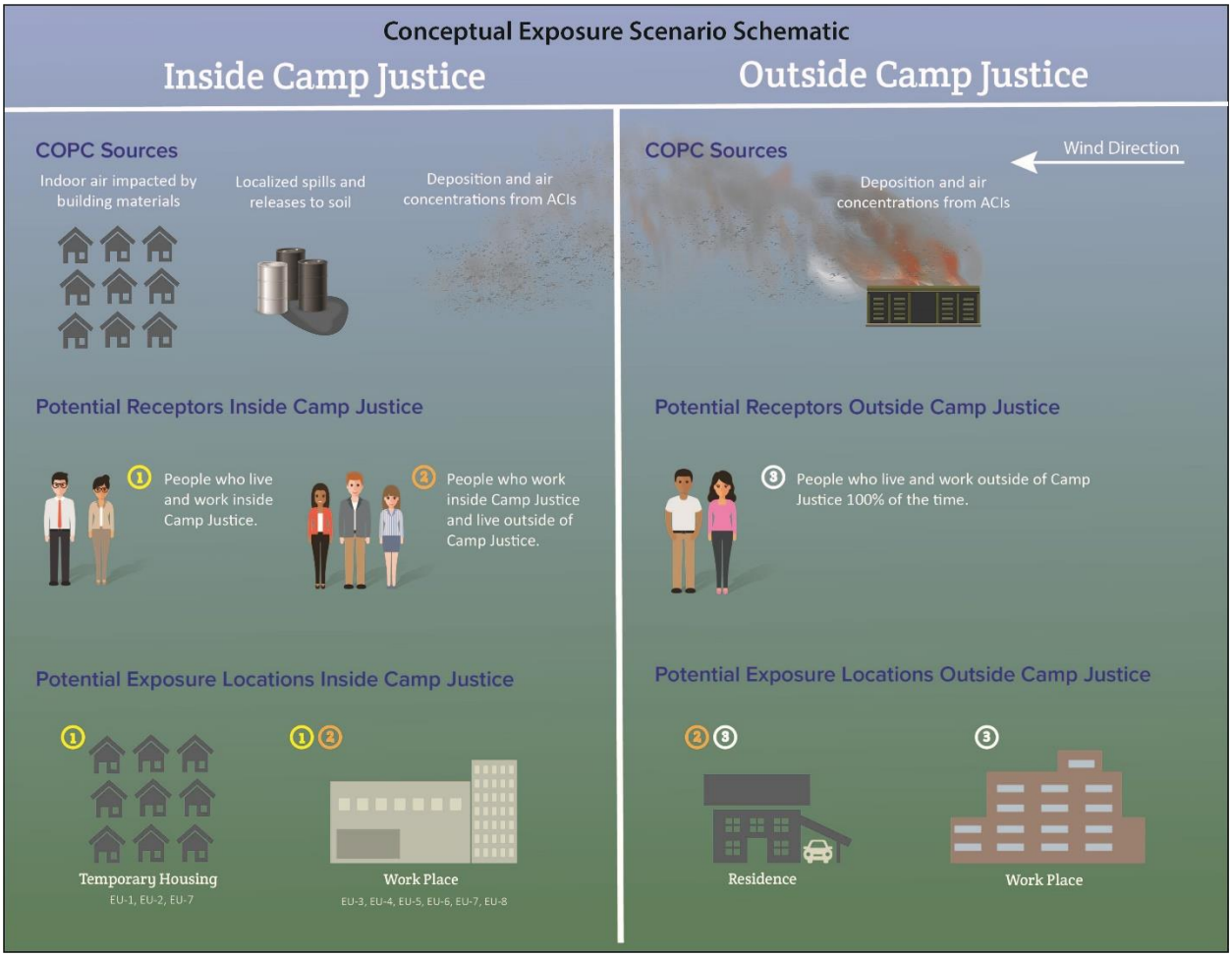
	ACI COPCs			
Metals/ Elements	Antimony Arsenic, Inorganic Barium Beryllium Cadmium	Chromium Cobalt Copper Lead Manganese	Mercury (+2) Mercury (elemental) Mercury (methyl) Nickel Phosphorus	Selenium Silver Titanium Zinc
Gases/ Particulates	Hydrogen cyanide NO_X Hydrogen sulfide	Hydrogen chloride Carbon monoxide Total reduced sulfur	Carbon dioxide Sulfur dioxide Total suspended particulates	PM_{10} $PM_{2.5}$
PAHs	1-Methylnaphthalene 1-Methylphenanthrene 2,3,5-Trimethylnaphthalene 2,6-Dimethylnaphthalene 2-Methylnaphthalene Acenaphthylene	Acenapthene Anthracene Benz[a]anthracene Benzo[a]pyrene Benza[e]pyrene Benzo[b]fluoranthene	Benzo[g,h,i]perylene Benzo[k]fluoranthene Biphenyl Chrysene Dibenz[a,h]anthracene Fluoranthene	Fluorene Indeno[1,2,3-cd]pyrene Naphthalene Perylene Phenanthrene Pyrene
Polychlorinated Biphenyls (PCBs)	Dichlorobiphenyl Trichlorobiphenyl Heptachlorobiphenyl	Hexachlorobiphenyl Monochlorobiphenyl	Nonachlorobiphenyl Octachlorobiphenyl	Pentachlorobiphenyl Tetrachlorobiphenyl
Dioxins	1,2,3,4,6,7,8-HpCDD 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF 1,2,3,4,7,8-HxCDD 1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDD 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDD 1,2,3,7,8,9-HxCDF	2,3,4,6,7,8-HxCDF 2,3,4,7,8-PeCDF 1,2,3,7,8-PeCDD 1,2,3,7,8-PeCDF	2,3,7,8-TCDD 2,3,7,8-TCDF OCDD OCDF
Semi-Volatile Organic Compounds	1,2,4-Trichlorobenzene 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2,4-Dimethylphenol 2-Chlorophenol	2-Methylphenol 2-Nitrophenol 3-Methylphenol 4-Methylphenol 4-Nitrophenol Acetophenone	Benzoic Acid Benzyl alcohol Bis(2-ethylhexyl) phthalate Butyl benzyl phthalate Carbazole Dibenzofuran	Dimethyl phthalate Di-n-butyl phthalate Di-n-octyl phthalate Hexachlorobutadiene Phenol Pyridine

[13]At this time, the ACIs are expected to operate for another 14 years (i.e., 30 years total).

	ACI COPCs			
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane 1,1,1-Trichloroethane 1,1-Dichloroethene 1,2,3-Trichlorobenzene 1,2,3-Trichloropropane 1.2.4-Trimethylbenzene 1,2-Dibromoethane 1,2-Dichloroethane 1,3,5-Trimethylbenzene 1,3-Dichloropropane 2-Butanone 2-Chlorotoluene 2-Hexanone	Benzene Bromobenzene Bromochloromethane Bromodichloromethane Bromomethane Carbon disulfide Carbon tetrachloride Chlorobenzene Chlorodibromomethane Chloroethane Chloroform Chloromethane Cis-1,2-Dichloroethene	Cis-1,3-Dichloropropene Dibromomethane Dichlorodifluoromethane Ethylbenzene Isopropylbenzene Methyl isobutyl ketone Methylene chloride n-Butylbenzene Xylene (m- & p-) o-Xylene p-Chlorotoluene p-Isopropyltoluene	n-Propylbenzene sec-Butylbenzene Styrene Tert-Butylbenzene Tetrachloroethene Toluene Trans-1,2-Dichloroethene Trans-1,3-Dichloropropene Trichloroethene Trichlorofluoromethane Vinyl chloride
Aldehydes	Acetaldehyde	Formaldehyde	Propionaldehyde	
Dinitro Toluenes	2,4-Dinitrotoluene	2,6-Dinitrotoluene		

Modeling was performed using the AERMOD Modeling System (Version 15181).[14] The air quality modeling analysis was performed in accordance with USEPA Combustor Protocol. The AERMOD model was used to compute outdoor air concentrations, dry deposition rates, wet deposition rates, and total deposition rates at 2,021 receptor locations. The modeled data were used to calculate the average annual concentration and deposition rate at each receptor location (USEPA 2005).

[14]https://www3.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod



Exposure Assessment Summary

For a COPC to pose a risk to human health, a complete exposure pathway must be present. A complete exposure pathway consists of the following elements:

- A source and mechanism of COPC release to the environment (e.g., ACI)
- An environmental transport medium for the released COPC (e.g., particulates released to the air from ACI emissions)
- An exposure point (e.g., a point of potential human contact with the impacted medium) which includes a location where humans are present and where there is an activity that results in exposure, referred to as the exposure scenario
- An exposure route at the point of exposure (e.g., inhalation, dermal contact)

A complete exposure pathway may result in possible health effects and was evaluated in the HHRA. An incomplete exposure pathway results in no exposure, no health effects, and was not evaluated further in the HHRA. An exposure scenario is the combination of complete exposure pathways to which a single receptor may be subjected.

A common approach to evaluating exposure pathways at sites involves developing a site conceptual site model (CSM), which describes how people might come into contact with environmental contamination. The CSM for NSGB and complete exposure pathways are summarized in Table 2-1. The following receptors were evaluated in the HHRA for NSGB:

Inside Camp Justice Exposure Scenario

The Inside Camp Justice exposure scenarios account for exposures to:

Adult Resident/Workers

- Live in EU-1, EU-2, or EU-7 (16 hrs/day); and
- Work in EU-3, EU-4, EU-5, EU-6, EU-7, or EU-8 (8 hrs/day).

Adult Workers

- Live in a residence not impacted by ACI emissions (i.e., no exposures at home); and
- Work in EU-3, EU-4, EU-5, EU-6, EU-7, or EU-8.
- Evaluated to determine exposure and risks associated with the work portion of the person's day.

Adult Workers who work Inside Camp Justice 8 hours/day and spend non-work hours (16 hours/day) Outside Camp Justice in an area **affected** by ACI emission were also evaluated in the HHRA.

Outside Camp Justice Exposure Scenarios

The Outside Camp Justice exposure scenarios account for exposures to:

Child and Adult Residents

- Live in a residential area Outside Camp Justice (24 hrs/day)

Adult Workers

- Work in a location Outside Camp Justice (8 hrs/day)

Combined Inside and Outside Camp Justice Exposure Scenario

The Combined Inside and Outside Camp Justice Exposure Scenario accounts for exposures to **Adult Resident/Workers**:

- Live in a residential area Outside Camp Justice (16 hrs/day); and
- Work Inside Camp Justice in EU-3, EU-4, EU-5, EU-6, EU-7, or EU-8 (8 hrs/day).

Toxicity Assessment Summary

Toxicity values for some chemicals may be available from several sources (e.g. USEPA and California Environmental Protection Agency). The following is the hierarchy of toxicity values used in this evaluation when multiple toxicity values exist for a given COPC. This hierarchy is based on the toxicity value order used in USEPA's RSL table.

- USEPA's Integrated Risk Information System (IRIS).

- The Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by USEPA's Superfund Technical Support Center (STSC) for the USEPA Superfund program.
- The Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRLs).
- The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's (OEHHA's) Chronic Reference Exposure Levels (RELs).
- Screening toxicity values in appendices for certain PPRTV assessments.
- The USEPA Superfund program's Health Effects Assessment Summary Table (HEAST).

Risk Characterization Summary

The purpose of the risk characterization is to combine the quantitative exposure estimates derived in the exposure assessment with the toxicity values described in the toxicity assessment to develop numerical estimates of cancer risks and noncancer hazards for all exposure scenarios evaluated in the HHRA.

USEPA Acceptable Risk Range and USEPA Risk Benchmarks

Risk managers use risk ranges and risk benchmarks to evaluate the significance of risks to people exposed to COPCs. Risk ranges and risk benchmarks provide perspective on whether or not environmental levels are potentially harmful, and help risk managers determine which areas and media may require further evaluation or actions.

USEPA Acceptable Cancer Risk Range

Cancer risk is an estimate of how exposure to a chemical may increase the normal or expected rate of developing cancer in a population of people. For carcinogenic risks, the USEPA recommends using an acceptable cancer risk range of 1.0E-06 (1 x 10^{-6} or 1 in 1,000,000) to 1.0E-04 (1 x 10^{-4} or 1 in 10,000), based on a reasonable maximum exposure (RME) scenario (USEPA 1991). In general, the USEPA considers cancer risks below 1E-06 to be so small as to be negligible

(i.e., below a level of regulatory concern; USEPA 1991). Conversely, cancer risks greater than 1E-04 are undesirable and typically require remedial action (e.g., soil removal).

USEPA Noncancer Hazard Benchmark

Noncancer health effects are expressed by a number known as the hazard quotient (HQ). The HQ compares the amount of a chemical that people may have been exposed to over a specified time period with the amount that is considered to be safe (i.e., have no adverse effects). If people are exposed to an amount greater than that considered safe for a particular chemical, then the HQ will be greater than one (1). Because people can be exposed to more than one chemical at a time, the HQs for different chemicals are added together to give an overall HI, unless data are available and an evaluation is done to indicate that they should not be added together. For the purpose of this HHRA, the HQs for the various chemicals were added together. USEPA policy considers chemical concentrations resulting in an HI greater than one (1) to be of concern for developing potential noncancer health effects.

In addition to calculating cancer risks and noncancer hazards, the following evaluations were also conducted:

- Modeled outdoor air concentrations were predicted for 2,021 receptor locations throughout NSGB and were compared to National Ambient Air Quality Standards (NAAQS) to identify any exceedances of these standards at locations Inside and Outside Camp Justice.
- Infant exposures via breast milk were evaluated using methods described in the USEPA Combustor Protocol (USEPA 2005).
- Lead risks for children and adults were evaluated using the Integrated Exposure Uptake Biokinetic (IEUBK) model and the Adult Lead Methodology (ALM) model.

The results of these evaluations indicated that:

- Modeled air concentrations exceeded NAAQS at locations at NSGB where people do not live or work. Exceedances were predicted at three locations for $PM_{2.5}$ [fine, inhalable particles with diameters that are 2.5 micrometers and smaller], one location for PM_{10} [inhalable particles with diameters that are 10 micrometers and smaller], and one location for NO_2).
- Infant exposures to dioxins via breast milk were below US national background levels.
- Lead risks to children and adult were below levels of concern established by the Centers for Disease Control and Prevention (CDC) of 5 µg/dL and the USEPA of 10 µg/dL. Navy Medicine, following CDC guidance, considers blood lead levels (measured not predicted) > 5 µg/dL elevated and requiring further evaluation by the health care practitioner (Bureau of Medicine and Surgery [BUMEDINST] 2014).

Health Risk Assessment Findings

Cumulative cancer risks were within the USEPA acceptable risk range of 1E-06 to 1E-04 (i.e., 1 in 1,000,000 to 1 in 10,000) and cumulative noncancer hazards exceeded one for Adult Resident/Workers Inside Camp Justice (these receptors were assumed to spend 16 hours/day at home and 8 hours/day at work). The highest cancer risks and noncancer hazards were associated with living in EU-1 (Old Cuzcos) or EU-2 (New Cuzcos). Cumulative cancer risks were less than 1E-06 and cumulative noncancer hazard were less than one for receptors living and/or working in EU-7 (Tents).

The impact of ACI emissions to risks and hazards associated with living Outside Camp Justice were negligible. Cancer risks for receptors who work Inside Camp Justice and live Outside Camp Justice

(the combined scenario) were lower than the risks for receptors who live and work Inside Camp Justice (Adult Resident/Workers Inside Camp Justice) and similar to receptors who only work Inside Camp Justice (Adult Workers Inside Camp Justice). Inhalation of formaldehyde in indoor air accounted for the majority of cumulative cancer risks (greater than 90% at some locations) and noncancer hazards (greater than 80% at some locations) associated with residential areas EU-1 and EU-2 and work sites EU-3, EU-6, and EU-8 (these are locations that have modular buildings, see Figure 2-3). Formaldehyde is frequently found in plywood, fiberboard, insulation, resins, glues, and other building materials in modular and stick-frame permanent buildings. The concentrations of formaldehyde detected in indoor air at Camp Justice were within the range of concentrations considered "Low" to "Mid" by the CDC for typical concentrations observed in manufactured homes (CDC Fact Sheet 2016). This indicates that people may be exposed to similar concentrations of formaldehyde in indoor air in buildings in the US. Since formaldehyde was detected in indoor air at typical US background concentrations, cancer risks and hazards were also calculated without formaldehyde concentrations. Removing formaldehyde concentrations from the calculations reduced the majority of the cancer risks to below 1E-06 and all noncancer hazards to below 1 (see Tables 2-2 and 2-3). Arsenic[15] and chlordecone[16] in soil contributed the most to cancer risk at EU-6 and EU-8, respectively, after formaldehyde in indoor air was removed from the calculations; however, the cancer risks were at the lower end of USEPA's acceptable risk range. Dermal contact with and ingestion of PAHs in

To evaluate sources of uncertainty and variability, which can influence the results of health impacts evaluated in the HHRA, an uncertainty assessment was conducted. A sensitivity analysis was performed to evaluate the impact of parameters or assumptions on the risk estimates. Four parameters selected for this evaluation include:

1. Risks Calculated Using an Alternative Particle Size Distribution for ACI Emissions.
2. Risks Calculated Using Emissions from the ACIs Only.
3. Risks Calculated Including Vapor Deposition.
4. Risks Calculated Including Dioxin-Like PCB Congeners.

Based on this analysis, changing the parameters or assumptions did not change the conclusions of the HHRA.

[15]Arsenic is a naturally-occurring element that is widely distributed in the earth's crust. Due to its geochemical characteristics, Cuban soils can be naturally high in heavy metals, including arsenic. Arsenic background levels for Cuba were determined to be approximately 19 mg/kg (Alfaro et al. 2015), and site-specific (NSGB) background levels range from 1.1 mg/kg to 2.7 mg/kg.

[16]Only one chlordecone sample (out of 60) was detected at Camp Justice; however, due to the elevated concentration, chlordecone was evaluated in the HHRA. The detected sample was collected from EU-8 (five other samples were collected in EU-8 and were not detected). The chlordecone risks presented in the HHRA are overestimated because the maximum detected concentration was used in the risk calculation (rather than the logarithmic 95% upper confidence limit [UCL]; see the decision rule in Section 3). Since NSGB receptors do not remain in a single location 24-hours a day, their exposure (and risk) to chlordecone is much lower than calculated because chlordecone was not detected in the other five soil samples collected from EU-8.

soil accounted for the majority of the cumulative cancer risks for EU-4. Cancer risks for EU-4 did not change after removing formaldehyde (see Table 2-3) because there are no modular buildings in EU-4. The cancer risks at EU-4 were also within the USEPA's acceptable risk range both when including and not including formaldehyde in the cancer risk calculation. Based on a review of the recently released USEPA toxicity values[17] the carcinogenic risks presented in this report would be approximately seven (7) times lower for benzo(a)pyrene (and other carcinogenic PAHs) had the updated toxicity values been used to calculate risk.

Exposures calculated for scenarios exclusively Outside Camp Justice (workers or residents), which are attributed to ACI emissions only, were below 1E-06 and a HI of 1 for all exposure durations evaluated except for 25 years. The cancer risk for the 25 year exposure duration slightly exceeded 1E-06. Cancer risks and noncancer hazards for current (16-year ACI lifetime) and future (30-year ACI lifetime) exposures were equivalent for all scenarios. This result indicates that COPCs associated with ACI emissions are not expected to add to cancer risks and noncancer hazards in the future.

Based on the results of the NSGB HHRA, current and future potential health risks related to sources within Camp Justice and ACIs were primarily due to formaldehyde in the indoor air of modular buildings. Cumulative cancer risks and noncancer HIs (calculated for all COPCs, including formaldehyde) were within the USEPA's acceptable cancer risk range of 1E-06 to 1E-04 and noncancer hazards exceeded the USEPA's hazard benchmark of 1 in some, but not all, cases that were evaluated in this HHRA. Since formaldehyde is frequently found in modular home building materials (not NSGB sources), current and future cumulative risks and hazards were calculated without formaldehyde concentrations. When potential health risks were calculated without the formaldehyde concentrations, cumulative cancer risks were within or below the USEPA's acceptable cancer risk range of 1E-06 to 1E-04 and noncancer hazards were below the hazard benchmark of 1. In addition, the impact of the ACIs to receptors living at NSGB was negligible. According to the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30 (Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions), "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted."

[17]The USEPA released its toxicological review of benzo(a)pyrene on January 20, 2017 which presented revised CSFs, inhalation unit risks (IURs), RfDs, and RfCs for benzo(a)pyrene (USEPA 2017). Due to the timing of the release of this report, the new toxicity values for benzo(a)pyrene could not be included.

Section 3: Ionizing Radiation

This section presents a discussion about ionizing radiation and the results of radiation surveys and measurements collected at Camp Justice.

Discussion

Current science suggests there is some cancer risk from any exposure to radiation. However, it is difficult to determine whether a particular cancer was caused by very low doses of radiation or by some other carcinogen. While radiation health experts disagree over the exact definition and the effects of a “low dose exposure,” US radiation protection standards are based on the premise that any radiation dose carries some risk, and that risk increases directly with dose. This method of estimating risk is called the "linear no-threshold” (LNT) model. The LNT model assumes that the risk of cancer increases linearly as radiation dose increases. This means, for example that doubling the dose doubles the risk and that even a small dose could result in a correspondingly small risk. Using current science, it is impossible to know what the actual risks are at very small doses. The risk of cancer from radiation also depends on age, sex, genetics, and lifestyle factors such as tobacco use (National Research Council of the National Academies 2006).

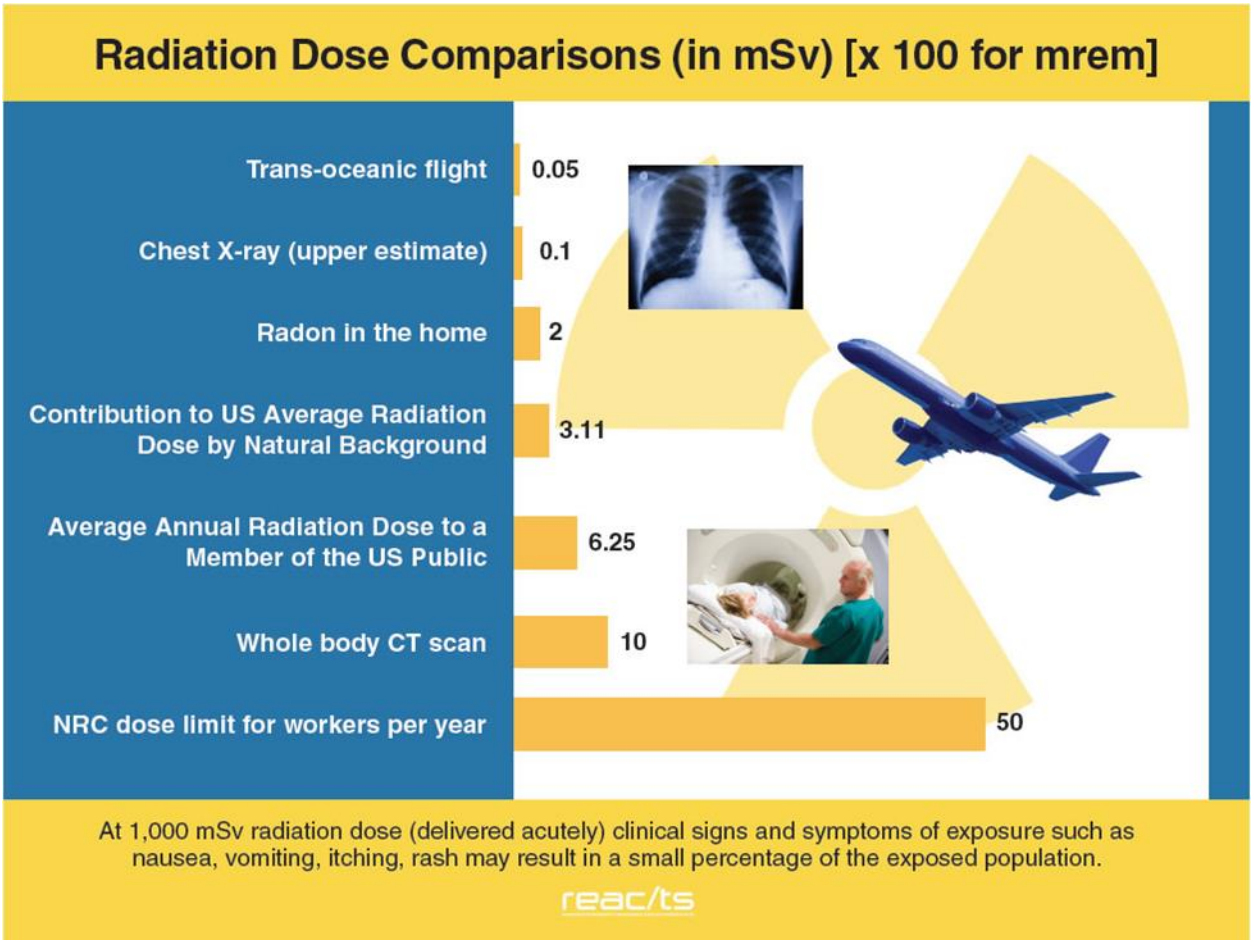
To protect the public, radiation workers, and the environment from the potential effects of chronic low-level exposure (i.e., less than 10 rem [100 mSv]), the current radiation safety practice is to prudently assume similar adverse health effects are possible with low-level prolonged exposure to radiation. Thus, the risks associated with low-level medical, occupational, and environmental radiation exposure are conservatively calculated to be proportional to those observed with high-level exposure. These calculated risks are compared to other known occupational and environmental hazards, and appropriate safety standards and policies have been established by international and national radiation protection organizations (e.g., International Commission on Radiological Protection [ICRP] and National Council on Radiation Protection and Measurements [NCRP]) to control exposures and limit potential harmful radiation effects.

Both the general public and occupational regulatory dose limits are set by federal agencies (i.e., USEPA, Nuclear Regulatory Commission [NRC]), the Department of Energy (DOE) and state agencies to limit exposures and therefore cancer risk (see the Regulatory Dose Limits table and Radiation Dose Comparisons figure on the following page). Other radiation dose limits are applied to limit other potential biological effects for workers' skin and lens of the eye to limit noncancer health effects such as erythema and cataracts.

Regulatory Dose Limits

Annual Radiation Dose Limits	Agency
Radiation Worker – 5 rem (50 mSv)	NRC, "occupationally" exposed
General Public – 100 mrem (1 mSv)	NRC, member of the public
General Public – 25 mrem (0.25 mSv)	NRC, decommissioning and decontamination all pathways
General Public – 10 mrem (0.10 mSv)	USEPA, air pathway
General Public – 4 mrem (0.04 mSv)	USEPA, drinking water pathway

Radiation Dose Comparisons



Results

Areas in and around Building AV-32 were evaluated for ionizing radiation using sensitive radiation detectors. Twelve (12) Thermoluminescent Dosimeters (TLDs) were also used to quantitatively measure radiation in Buildings AV-29, AV-31, AV-32 and AV-34. The results indicated the presence of naturally-occurring radioactive material consistent with what would typically be found throughout the world in construction/building materials and soil. Ionizing radiation survey locations and results are summarized in this section and described in detail in Appendix J.

The gamma exposure rate survey inside Building AV-32 included exposure rate measurements taken above the floor in the building at the intersection of the existing floor slabs. These measurements were made at approximately 3 to 4 feet from the floor (waist height) to represent the location of the whole body, as defined in radiation dose assessments. Measurements were not collected in the fenced storage area in the northwest portion of the floor or the temporary buildings in the southwest portion. Three or four evenly spaced measurements were generally collected in accessible rooms in the first and second floors along the east and west sides of the building.

Radiological survey measurements indicated dose rates generally in the range of 2 to 4 µR/hr which is within normal expected background levels for this area. The only areas with dose rates exceeding 4 µR/hr were inside wash rooms/latrines where measurements were made adjacent to porcelain sinks; some porcelain is known to contain higher levels of naturally-occurring radionuclides than other building materials. Ordinary ceramics often contain elevated levels of naturally occurring radionuclides (e.g., Potassium-40) and the various members of the uranium and thorium decay series (International Atomic Energy Agency 2010). All gamma dose rate survey results inside Building AV-32 were consistent with naturally-occurring background levels.

A walkover survey was performed to assess elevated levels around Building AV-32. Some anomalies in measurements ranged from about two to four times background levels. These anomalies were not necessarily the result of residual radioactive contamination (e.g., from radium painted dials). The anomalies were most likely the result of naturally occurring radioactivity in construction or fill materials. No attempt was made to evaluate the radiation dose impact from these anomalies as they are small in size and there are no full-time occupants of these areas outside Building AV-32.

The results of the 12 TLDs placed in and around Building AV-32 reported dose equivalent, which is the dose recorded on the area dosimeter minus the dose from the control TLD. No net deep or shallow dose (external gamma dose), reported as 0 millirem (mrem), were reported for any of the 12 area TLDs for the time deployed (37 days). Given that the minimum reportable dose is 1 mrem, the total annual dose at each location can be considered less than 12 mrem per year. For

context, this can be compared to the average background radiation from natural sources including cosmic and terrestrial radiation which results in a radiation dose of about 240 mrem per year. This is also well below the federal annual dose limit of 100 mrem per year for members of the general public.

Conclusions

Based on the results of radiation surveys and measurements conducted, it is not likely that an individual would receive any additional radiation dose above normal background radiation from the areas occupied in the surrounding OMC trailers, tents and office/courtroom buildings located on Camp Justice at NSGB. Risk estimates that are used to predict health effects in exposed individuals or populations are based on epidemiological studies of well-defined populations (e. g., the Japanese survivors of the atomic bombings in 1945 and medical patients) exposed to relatively-high doses delivered at high dose rates. Epidemiological studies have not demonstrated adverse health effects in individuals exposed to small doses (less the 10 mrem) delivered over a period of many years.

Section 4: Epidemiology

This section presents the epidemiological investigation conducted in response to the DoD IG hotline complaint. As part of the PHR, NMCPHC EpiData Center (EDC) conducted a review of an alleged cancer cluster specifically to: (1) review medical records for service members' named in the original DoD IG complaint to determine if there was sufficient evidence to confirm a diagnosis of cancer (e.g., case validation) and (2) conduct the appropriate type of epidemiologic investigation based on the findings of a review of all available medical records of the military personnel assigned to OMC. See Appendix E for the full report and details.

Initial Case Reviews and Cohort Identification

The CNIC IG provided a list of military members with personal identifying information associated with the DoD IG complaint for the initial review of cases. To identify the entire cohort of military personnel assigned to OMC, the Office of the Naval Inspector General (NAVINSGEN) provided a roster of all military personnel assigned for duty at OMC to NMCPHC to conduct a complete review. OMC provided the initial date of travel to Camp Justice for each military member.

Cancer Cluster Determination Methods

The CDC published guidelines to determine if a cancer cluster investigation is warranted and includes the process for conducting the investigation (CDC 2013). The CDC's four-step process for evaluating suspected clusters, as well as the NMCPHC's case series analysis process, is summarized on Figure 4-1. The definition of a cancer cluster is a greater number than expected of the same or related cancer cases in a population that shared the same location or exposure over the same period of time.

> Epidemiology is the study of the distribution of disease and risk factors or determinants of disease in specified populations and is considered the basic science of public health.

There are several points to consider when investigating a suspected cancer cluster:

- First, types of cancer vary in causes, predisposing risk factors (e.g., genetics, lifestyle, immune status, age), target organs, and the rates of occurrence.
- Second, cancers are often caused by a combination of factors which interact in a way that is not fully understood.
- Third, the amount of time that elapsed from first exposure to the suspected agent and the diagnosis of cancer, usually called latency, is typically decades, making it very difficult to link past exposure to the cancer diagnosis of concern (Armed Forces Health Surveillance Center 2012).

If a situation meets the statistically minimum requirements of a cancer cluster, then a cohort or case-control epidemiologic study is conducted. If a cancer cluster investigation is not supported by the guidelines*, a case series analysis should* be provided. A case series analysis consists of a review of the available medical information and peer-reviewed cancer literature for each cancer type to describe the associated risk factors and latency.

In this investigation, the latency for each suspected case was measured using the first date of arrival at Camp Justice from the OMC roster to the first diagnosis date of the suspected cancer documented in the medical records.

Case Validation Results

The case validation process identified four (4) different cancers diagnosed in five (5) individuals who traveled to and worked at Camp Justice prior to his or her diagnosis of a primary malignant cancer. One metastatic cancer case from the original complaint was excluded from this analysis because the incident cancer was diagnosed sometime prior to the person's assignment to OMC. One primary cancer case was diagnosed prior to the person's first duty date in Camp Justice. The number and types of cancer in this investigation do not meet the CDC definition of a cancer cluster and a formal cluster investigation was not scientifically supported. A case series analysis is provided to describe any risk factors that might be shared among the cases.

Case Series Analysis Results

The environmental risk factors and latencies for each of the validated cancers are discussed below. A risk factor is anything that increases a person's chance of developing cancer. This may include age, gender, family history, race and ethnicity, and lifestyle (e.g., diet, exercise, alcohol, smoking). Environmental risk factors include home and work exposure (e.g., solvents and pesticides), exposure to infections, viruses, and allergens, and exposure to ionizing radiation (e.g., x-rays). The validated cancers include:

- Appendiceal adenocarcinoid
  - Appendiceal carcinoma is a rare form of colorectal cancer. It strikes the appendix. The cancer's growth can lead to a blockage in the appendix, which can result in appendicitis. It also can spread to the stomach. The initial diagnosis of this disease may be delayed because its symptoms are similar to appendicitis (American Society of Clinical Oncologists 2016).
  - Risk factors: No known environmental risk factors (American Society of Clinical Oncologists 2016).
  - Latency: No established latency period.

- Breast
  - Breast cancer is a disease in which malignant (cancer) cells form in the tissues of the breast. The damaged cells can invade surrounding tissue, but with early detection and treatment, most people continue a normal life.
  - Risk factors: Genetic risk factors, including BRCA1 and BRCA2 (breast cancer genes), a family history of breast cancer in a primary relative (e.g. parents, siblings), timing of first birth (greater than 30 years of age), never having given birth (nulliparity), hormone therapy use, obesity, and alcohol consumption (more than 2 drinks per day; American Cancer Society 2015a; Jardines et al. 2015).
  - Environmental Exposures: Exposure to x-rays, a type of ionizing radiation, in the chest area during adolescence (American Cancer Society 2015a).
  - Latency: 15-20 years for exposure to ionizing radiation (Jardines et al. 2015).
- Colorectal
  - Colorectal cancer is cancer that occurs in the colon or rectum. Sometimes it is called colon cancer.
  - Risk factors: No known environmental risk factors. Lifestyle risk factors include smoking, being overweight or obese, inactive lifestyle, and heavy alcohol use (American Cancer Society 2011, 2016).
  - Latency: No known latency due to environmental exposure. Latency period associated with exposure to tobacco smoke is 30-40 years (American Cancer Society 2011).
- Myxoid liposarcoma
  - Liposarcoma is a rare cancer of connective tissues that resemble fat cells under a microscope. It accounts for up to 18% of all soft tissue sarcomas. Myxoid liposarcomas are the second most common type of liposarcoma, representing 30% –40% of all liposarcomas in the limbs; occurring most commonly in the legs, particularly the thigh, followed by the buttocks, retroperitoneum, trunk, ankle, proximal limb girdle, head and neck, and wrist. Liposarcomas occur in the intermuscular fascial planes or deep-seated areas and present as a large, slow-growing, painless mass (American Cancer Society 2015b).
  - Risk factors: Exposure to ionizing radiation, typically during medical treatment, in the area of the tumor (American Cancer Society 2015b).
  - Latency: The median latency period for all radiation-induced sarcomas is about 10 years (Neuhaus SJ et al. 2009).

There are no known environmental risks factors for two of the types of cancers at Camp Justice (appendiceal adenocarcinoid and colorectal). The only common risk factor for the other types of cancer at Camp Justice (breast and myxoid liposarcoma) were exposure to ionizing radiation. This

PHR concluded that exposure to ionizing radiation was unlikely to be above background (see Section 3) while at Camp Justice.

Discussion

This case series analysis identified four (4) different types of cancer among five (5) people. Because the development of cancer is multifactorial, it is not scientifically valid to group all cancers together as a single health outcome. According to the CDC, cancer is the second leading cause of death in the US, with one in four deaths attributable to some form of cancer. Approximately one in two men and one in three women will be diagnosed with some form of cancer in their lifetime. Because cancer is common, cases might appear to occur with alarming frequency within a community even when the number of cases is within the expected rate for the population. As the population ages in any given community, many residents will eventually be diagnosed with some type of cancer, thus adding to the perception of an excess of cancer cases in a community. Multiple factors affect the likelihood of developing cancer, including age, genetic factors, and lifestyle behaviors such as diet, smoking, and alcohol consumption. As noted previously, a statistically significant excess of cancer cases may occur by chance alone and without any known external exposures (CDC 2013).

Latency is one important factor when considering the association between the dates of initial exposure to an environmental factor and the diagnosis of cancer. Latency estimates are based on the average time observed among the cancer cases reported in the literature. Latency periods may be shorter in individuals with genetic predispositions for tumor development. These individuals may be referred to as "hypersensitive" to agents that initiate and complete the cancer process. For cancer to be associated with an environmental or occupational exposure, a complete pathway from the exposure to the individual must exist. The fact that an exposure to a carcinogenic agent occurred does not make the diagnosis of cancer inevitable. The risk of cancer due to external environmental exposures is based on two factors – the frequency and intensity of exposure to a carcinogenic agent and the susceptibility of the individual. The person's genetics, lifestyle choices, and the level of mental and physical stress on the body govern the susceptibility of the individual (Schottenfeld D. et al. 2006). For an epidemiology study to be meaningful, a complete exposure pathway from the exposure to the individual must be demonstrated and there must be a sufficient number of cases to study. However, a complete exposure pathway does not necessarily mean that a public health hazard exists. Rather, specific exposure conditions, such as the route of exposure and the magnitude, frequency, and duration of exposure need to be examined more closely to evaluate possible health implications of the exposures.

Findings and Recommendations

1. Based on the types and number of cancers observed and the lack of recognized occupational and environmental risk factors, it is unlikely that environmental or occupational exposures are associated with these cancers. Current epidemiologic methods are not adequate to determine if there were other factors (e.g., genetic errors or modifications) in these cases.
2. At the 18 July 2016 NMCPHC presentation to OMC personnel at OMC Headquarters, the NMCPHC team was asked why civilians and contractors who worked at Camp Justice were not included in this investigation. NMCPHC requested OMC provide a census of all OMC civilians and support contractors to determine if there would be a sufficient number of potential subjects. A combined count of 414 persons was provided. This number of potential subjects would not likely increase the total number of cancers sufficiently to conduct a cancer cluster study. Additionally, to conduct an unbiased study, complete medical, occupational, family history, and lifestyle data for each civilian and contractor would be required. Two of the key aspects of conducting an unbiased study are how study participants are selected and the amount of information that is available for all study participants. Using participants without complete study information (information bias) or allowing participants to volunteer for a study (selection bias) jeopardizes the validity and power of the study. For a study to fully investigate the risk of cancer from environmental exposures while controlling for lifestyle and genetic risk factors, more than 100 cases of the same or similar cancers would be required.
3. Recommend this PHR Report be disseminated to OMC personnel. Feedback from other NMCPHC epidemiological investigations at other locations has indicated that the contents of these reports may provide useful information when discussing an individual's cancer risk with a health care provider.

Section 5: Summary of PHR Findings Relative to the Original DoD IG Hotline Complaint

This section presents a summary of the findings of the PHR relative to each of the original DoD IG Hotline Complaints.

DoD Hotline Case Referral

14 July 2015 Hotline Case No. 20150714-032150-CASE-01

Complaint: OMC location of tents and trailers used for housing may have been a dumping ground for fuel in the past

Finding:

The results of the PHR did not indicate that the tents and trailers used for temporary housing at Camp Justice were located in an area that may have been a dumping ground for fuel. The results of the PHR demonstrated that the human health risks in the location of the tents and trailers were low and within the acceptable risk range established by the USEPA of 1E-06 to 1E-04 (e.g., 1 in 1,000,000 to 1 in 10,000).

A comprehensive environmental sampling program was executed as part of the PHR to investigate potential contamination of soil, air, and tap water at Camp Justice. Soil samples were collected to determine if there may have been releases of chemicals to soil associated with the former airfield and other operations at Camp Justice. Sixty nine (69) soil samples were collected throughout Camp Justice in order to address concerns associated with potential chemicals in soil (Figure 5-1). These samples were analyzed for numerous chemicals from metals, to fuel-related chemicals such as gasoline and diesel, to herbicides and pesticides. Key indicators of dumping of fuel are elevated health risks, frequent detections of elevated concentrations of gasoline, diesel, PAHs, and semi-volatile organic compounds (SVOCs). The concentrations of these key indicators were all very low, were infrequently detected (other than PAHs), and were not indicative of dumping of fuel.

- Gasoline/Diesel: The USEPA has not specifically established health comparison criteria for gasoline/diesel in soil; however, some states have developed criteria for these chemicals. For example, several states have established criteria they consider protective of human health for gasoline and diesel (see In-Text Table 1: State Cleanup Levels for Total Petroleum Hydrocarbon). The maximum detected concentrations of gasoline and diesel at Camp Justice were 0.6 mg/kg and 360 mg/kg, respectively. These chemicals were also

detected infrequently (i.e., 6.7% and 15% of samples respectively). The concentrations are much lower than the criteria. In-Text Table 1: State Cleanup Levels for Total Petroleum Hydrocarbon below provides levels for gasoline, diesel, and other petroleum fractions. These low concentrations, coupled with infrequent detections, were not indicative of dumping of fuel.

In-Text Table 1: State Cleanup Levels for Total Petroleum Hydrocarbon (TPH)

TPH Cleanup Level	Residential (mg/kg)	Industrial (mg/kg)	TPH Cleanup Level	Residential (mg/kg)	Industrial (mg/kg)
Oklahoma			**Washington**		
Gasoline	50	500	Gasoline	100	100
Diesel	50	500	Diesel	2,000	2,000
Lube Oil	50	500	Lube Oil	2,000	2,000
Alaska			**Oregon**		
Gasoline		50 – 1,000	Gasoline	1200	20000
Diesel		100 – 2,000	Diesel/Heating Oil	1100	14000
Residual Range		2,000	Mineral/Insulating Oil	2800	36000

- PAHs (e.g., benzo(a)pyrene) were detected at very low concentrations in the vicinity of the tents and trailers used for housing. The highest concentration of PAHs was detected proximate to Building AV-34 which is not located close to the tents and trailers on the former airfield runway. The human health risks associated with detected concentrations of PAHs are within USEPA acceptable cancer risk range and/or below noncancer benchmarks.

  Low levels of PAHs are frequently detected in the environment and are often associated with natural background sources (e.g., automobile exhaust, forest fires). The concentrations of PAHs measured proximate to the former airfield runway are consistent with background concentrations published by the Agency for Toxic Substances and Disease Registry (ATSDR) and not fuel dumping (see Table 5-3 in Appendix C; ATSDR 1995).
- SVOCs were detected infrequently (only 6 of 74 SVOCs [not including PAHs which were discussed separately]) and the frequency of detection ranged from 1.7% to 23%. The human health risks associated with detected concentrations of SVOCs were low and within the acceptable cancer risk range established by the USEPA. These low concentrations, coupled with infrequent detections, were not indicative of dumping of fuel.

For more detailed information/context regarding this finding please refer to Section 2 and Appendix C.

Complaint: The old commissions' building potentially contains asbestos and possibly other carcinogens and the new commissions' building was built on the old runway and could be contaminated

Finding:

The results of the PHR did not indicate that the old commissions' building potentially contains asbestos and other carcinogens at concentrations that exceed the OSHA PELs or the acceptable cancer risk range established by the USEPA, respectively. Further, the results of the PHR did not indicate that the new commissions' building is contaminated as a result of being built on the old runway.

Old Commissions' Building (AV-34)

Asbestos in Building AV-34: Asbestos was present in some of the building materials (e.g., certain non-friable floor tiles with mastic) in Building AV-34, as is permitted by the USEPA/US Navy "Management In Place" regulations/policies. These regulations/policies allow asbestos to remain in a building as long as it is non-friable (i.e., the asbestos is encapsulated or otherwise bound so that it is not present in air). The results of the asbestos investigation at Building AV-34 are summarized below:

- Four indoor air samples were collected from Building AV-34 and were analyzed for asbestos. The range of detections was 0.006 fiber/cc to 0.01 fiber/cc which is less than the OSHA PEL of 0.1 fiber/cc. Even though asbestos was present on the sampling filters, the quantity was near the limit of detection even when sampled for a 10-hour period. The detection limit of an analytical method tells how low a concentration can be said to be measured.
- Visual inspections of all spaces in Building AV-34 determined that all asbestos-containing material identified in previous asbestos inventory surveys was not a health concern because it is non-friable.
- The epidemiological investigation found no cancers associated with asbestos exposure.

All aspects of the NSGB Asbestos Management Program (AMP) were not fully implemented. For more detailed information/context regarding this finding please refer to Appendix F.

Other Carcinogens in Building AV-34: A comprehensive sampling program was implemented at Building AV-34 to characterize concentrations of chemicals (including carcinogens and noncarcinogens) that might be present in indoor air, basement air, crawl space air, soil, and tap water at the building. The results of the investigation of other carcinogens at Building AV-34 is summarized below:

- Five indoor air samples were collected from multiple locations (crawl space, basement, courtroom, and each wing) at Building AV-34 and very few chemicals were detected. All of the chemical concentrations detected in indoor air were low and were within the acceptable cancer risk range established by the USEPA.
- Two air samples were collected for radon from the crawl space and basement. The crawl space sample was not detected and the basement sample was detected at 0.9 pCI/L, which is less than the USEPA risk-based action level of 4.0 pCI/L.
- Fourteen soil samples were collected from outside Building AV-34. PAHs were detected in soil samples collected immediately north of the building and immediately southwest of the building at concentrations greater than NSGB natural background; however, the concentrations were similar to typical US urban background. As documented in the HHRA, the health risks associated with potential exposure to these concentrations were within the acceptable cancer risk range established by the USEPA. Based on the review of the USEPA new toxicity value for benzo(a)pyrene,[18] the carcinogenic risk for benzo(a)pyrene and other carcinogenic PAHs would be approximately 7 times lower.
- Tap water samples were collected from two locations and all results were less than the USEPA MCLs. Bottled water is and has always been provided throughout Camp Justice for ingestion.

For more detailed information/context regarding these findings, please refer to Section 2 (Human Health Risk Assessment) and Appendix C (Naval Station Guantanamo Bay Human Health Risk Assessment for Camp Justice February 2017).

New Commissions' Building (ELC – Commissions' Room)

For the potential contamination from the former airfield runway, see the above discussion regarding soil concentrations observed on the runway.

[18]The USEPA released a toxicological review of benzo(a)pyrene on January 20, 2017 which presented revised CSFs, IURs, RFDs, and RfCs for benzo(a)pyrene (USEPA 2017). Due to the timing of the release of this report, the new toxicity values for benzo(a)pyrene could not be included.

Complaint: OMC military/civilian personnel were likely exposed to carcinogens and 7 individuals alleged to have been diagnosed with cancer

Finding:

The results of the PHR did not indicate that OMC military/civilian personnel have been exposed to carcinogens at levels exceeding the acceptable cancer risk range established by the USEPA. Further, the medical records data from the roster provided by OMC for all military personnel who worked at Camp Justice were reviewed and five cases of cancer were validated/confirmed. Four different types of cancers were diagnosed and the only common environmental risk factor among two of the cancer types (breast and myxoid liposarcoma) was exposure to ionizing radiation. The other cancer types (appendiceal adenocarcinoid and colorectal) have no known environmental risk factors. The sixth case included in the original complaint was excluded from the study because the type of cancer was metastatic and evidence of the primary cancer was before the person was assigned duty on Camp Justice. The seventh case was excluded because the date of diagnosis of primary cancer was before the first date of duty on Camp Justice.

The PHR evaluated ionizing radiation exposure at Camp Justice and concluded, based on the results of the radiation surveys and measurements (TLDs and radon detectors) conducted, it is not likely that an individual would receive any additional radiation dose above normal background radiation from the areas occupied in the surrounding OMC trailers, tents, office, and courtroom buildings located on Camp Justice at NSGB.

Based on the types and number of cancers observed and the lack of recognized occupational and environmental risk factors, it is unlikely that an environmental or occupational exposure is associated with these cancers. The term “unlikely” means that the evidence is insufficient to connect the environmental and occupational conditions to the observed cancers.

For more detailed information/context regarding this finding please refer to Section 4 (Epidemiology) and Appendix E (Epidemiological Evaluation for Camp Justice December 2016).

Section 6: Public Health Summary Conclusions

This section summarizes the conclusions of the HHRA and the epidemiologic investigation of the alleged cancer cluster.

Human Health and Environmental Exposures

After the preliminary public health screening risk assessment was completed in February 2016 (Appendix H; NMCPHC 2016b), additional environmental data were collected and a final HHRA (see Appendix C - Naval Station Guantanamo Bay Human Health Risk Assessment for Camp Justice February 2017) was conducted to characterize current and future potential cumulative health risks related to exposures to environmental sources within Camp Justice and to the NSGB ACIs.

Final Human Health Risk Assessment

The results from the Preliminary Public Health Screening Risk Assessment (Appendix H; NMCPHC 2016b) were integrated into the final HHRA and were used to calculate cumulative cancer risks and/or noncancer hazard indices (HIs) for all COPCs and all pathways of exposure (e.g., inhalation of indoor air, inhalation of outdoor air, ingestion of soil, and dermal contact with soil). The final HHRA was conducted for receptors who work and/or live (workers and/or residents) at Camp Justice for 9 months, 3 years, 6 years or 25 years. Workers and residents were assumed to be exposed to either the reasonable maximum exposure (RME) or the maximum exposure to various media within the EUs 100 percent of their day, as follows:

- Workers Inside Camp Justice were assumed to spend 8 hours per day, five days per week for the duration of their exposure period (i.e., 9 months, 3 years, 6 years, or 25 years) at their respective EU and be exposed to the maximum outdoor air concentration measured at Camp Justice, the maximum indoor air concentration for their EU and the RME soil concentration for their EU.
- Residents Inside Camp Justice were assumed to spend 16 hours per day home and 8 hours per day at work for the duration of their exposure period (i.e., 9 months, 3 years, 6 years, or 25 years) and be exposed to the maximum outdoor air concentration, the maximum indoor air concentration for their EU and the RME soil concentration for their EU.
- Workers Outside Camp Justice were assumed to spend 8 hours per day, five days per week for the duration of their exposure period (i.e., 9 months, 3 years, 6 years, or 25 years) at the maximum ACI modeled concentration location for any work area.
- Adult and Child Residents Outside Camp Justice (family members) were assumed to spend 24 hours per day, 350 days per year at a location that is maximally impacted by ACI emissions.

People are expected to encounter a range of concentrations during their daily activities at different locations on NSGB. Using maximum concentrations associated with a single location is expected to overestimate risks. The exposure assumptions in an HHRA (e.g., duration and frequency) differ by population groups (e.g., active duty, OMC civil service, base operations support). People on temporary additional duty (TAD) orders may spend as little as a few days to a few weeks several times a year at Camp Justice.

When commissions are in progress, supporting personnel berth for short durations (1-2 weeks; 2 to 4 times per year) while others (e.g., OMC active duty, civil service, and contractors) are on permanent orders and work and/or live there for a longer fixed period of time (e.g., 9 months, 3 years, 6 years) and typically live in assigned housing at NSGB (see Figure 5-2 - Types of Personnel and Periodicity of Working and Living on Camp Justice). Risks for supporting personnel working and/or living at Camp Justice for shorter periods of time would be less than those presented in the HHRA. Since Camp Justice was established in 2007/2008, few if any people have worked at Camp Justice beyond a time period of 9 years; however, the 25 year worker was evaluated to ensure consideration was given to a worker who may continue to work at Camp Justice for this extended period of time, under the same conditions.

Current and future potential health risks related to sources within Camp Justice and the ACIs were within the USEPA acceptable risk range of 1E-06 to 1E-04 (e.g., 1 in 1,000,000 to 1 in 10,000). The HI exceeded the USEPA noncancer benchmark of 1 for a number of exposure scenarios. Most of the cumulative risks and HIs were primarily due to formaldehyde in the indoor air of modular buildings. Inhalation of formaldehyde in the indoor air of modular buildings accounted for the majority of cumulative cancer risks (greater than 90% at some locations) and noncancer hazards (greater than 80% at some locations). Formaldehyde is frequently found in plywood, fiberboard, insulation, resins, glues and other building materials in modular and stick-frame, permanent buildings. Concentrations of formaldehyde in indoor air ranged from 5 $\mu g/m^3$ to 75 $\mu g/m^3$. According to the CDC, background air concentrations in the US range from 12 to 60 $\mu g/m^3$. Only one of 28 indoor air formaldehyde samples exceeded this range (75 $\mu g/m^3$). The concentrations of formaldehyde detected in indoor air at Camp Justice were within the range of concentrations considered "Low" to "Mid" by the CDC for typical concentrations observed in manufactured homes (CDC Fact Sheet 2016). These concentrations indicate that people may be exposed to similar concentrations of formaldehyde in indoor air in buildings in the US. All concentrations were below the OSHA PEL of 925 $\mu g/m^3$ for employee occupational exposure in the workplace.

The cumulative cancer risks and HIs for all populations and exposure scenarios, considering all COPCs, are presented on Table 2-2. The calculated risks and HIs with formaldehyde removed from the calculations are presented on Table 2-3. The cumulative risks for Inside Camp Justice for all COPCs ranged from 1.2E-07 to 6.1E-05, depending on the locations where the individual

population groups worked and/or lived (see Table 2-2). The ACI emissions did not contribute significantly to the cancer risks or HIs at Camp Justice. The cumulative risks Inside Camp Justice, when formaldehyde was removed from the calculations, significantly decreased for most exposure scenarios (see Table 2-3). Cumulative cancer risks were the same for current and future Adult Worker exposure scenario at EU-4. Cancer risks and HIs calculated for exposure scenarios exclusively Outside Camp Justice (workers or residents), which were attributed to ACI emissions only, were below 1E-06 and an HI of 1 for all exposure scenarios and all exposure durations except 25 years. The cancer risk for the 25 year resident was approximately 2.5E-06.

Following USEPA Superfund methodology, cancer risks were derived using upper-bound estimates of the true risks to ensure the risks were conservative and not underestimated. The calculated cancer risks based on the assumed exposure conditions were likely much higher than the actual cancer risks. The risk estimated for each chemical might be significantly lower than the value presented, and may be as low as zero. According to the USEPA OSWER Directive 9355.0-30 *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted."

The HIs, which were also based on upper bound estimates, exceeded the USEPA noncancer benchmark of 1 for a number of exposure scenarios. Cumulative noncancer HIs for Adult Resident/Workers ranged from 0.7 to 5.1 (Table 2-2). Cumulative noncancer HIs significantly decreased (i.e., all HIs were less than one) when formaldehyde was removed from the calculations.

Following USEPA methodology for Superfund, the approach to assess noncancer health effects compared RMEs to conservative RfDs and RfCs, which have uncertainty factors incorporated into them to ensure protection of public health. If the RME for a chemical is below the RfD or RfC, it can be concluded that the exposure is not likely to cause adverse health effects; however, if the RME is above the RfD or RfC, it cannot be concluded that the exposure is causing adverse health effects.

Summary of Formaldehyde Effects

As previously indicated, the approach used (Superfund methodology) to assess noncancer health effects compared RMEs with conservative RfDs and RfCs, which have uncertainty factors incorporated to ensure protection of public health. For this HHRA, the potential for formaldehyde to cause noncancer effects was calculated using the RfC of 0.0098 mg/m^3 or 7.8 parts per billion (ppb; available on the USEPA RSL table; USEPA 2016). The RfC for formaldehyde was based on a 1989 study assessed by ATSDR in 1999. The endpoint was described as "Clinical symptoms of mild irritation of the eyes and upper respiratory tract and mild damage to the nasal

epithelium [outer layer of cells in the nose]." The study on which ATSDR relied has been criticized. The World Health Organization (WHO 2010) states, "Overall, this study cannot be used for risk assessment owing to the lack of an exposure-dependent effect." According to WHO (2002), formaldehyde is produced in the body, is soluble in water, and reacts quickly with biological tissues; therefore, the site of first contact with the chemical is expected to be the most sensitive site of toxicity. According to WHO (2010), a value of 0.125 mg/m^3 (100 ppb), in the indoor environment (24 hours) was considered safe for the entire population against sensory irritation, including chronic sensory irritation.

According to WHO (2001), 80 ppb "represents an exposure level at which there is a negligible risk of upper respiratory tract cancer in humans." International Agency for Research on Cancer (IARC) and the National Research Council (NRC) concluded that there is sufficient evidence of human carcinogenicity, but did not evaluate at what levels of exposure the cancer might occur (IARC 2012, NRC 2014). Re-analyses of the data and analysis of more recent data (Marsh et al. 2016, Möhner and Wendt 2016, Checkoway et al. 2015) raise specific problems regarding the analyses in the reports on which those conclusions relied. These recent analyses conclude that formaldehyde is not likely to be a human carcinogen at least below 80 ppb.

Indoor air concentrations of formaldehyde at Camp Justice ranged from 1.9 to 61 ppb and the average concentration was 15.4 ppb. All values were below the 100 ppb level considered safe for noncancer effect, as well as the 0.1 mg/m^3 [80 ppb] level determined to prevent long-term health effects, including cancer (WHO 2010).

Epidemiology and Environmental Exposures

Background Information

Cancer is a common disease, although some forms of cancer are relatively rare. Men in the US have a 1 in 2 chance and women have a 1 in 3 chance of developing any cancer in their lifetime.[19] Consequently, it is not unusual for members of the general public to conclude that there is "a lot of cancer" in a particular community. However, the overall incidence of cancer within a community is not the same as a cancer cluster. A cancer cluster is defined as a high number of cancer (the same or similar types of cancer) cases in a particular geographic area over a defined period of time. The goal of a cancer cluster

> CDC defines a **cancer cluster** as a greater-than-expected number of cancer cases that occurs within a group of people in a geographic area over a defined period of time. As a group, cancers are very common. One of every four deaths in the US is attributable to some form of cancer. Multiple factors affect the likelihood of developing cancer, including age, genetic factors, and lifestyle behaviors (e.g., diet and smoking).

[19]American Cancer Society, Cancer Facts & Figures 2017 http://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2017.html.

investigation is to find/determine if there is a causal association between exposure to environmental contaminants (or other cancer causing agents) and cancer. Cancer clusters due to external exposures are very rare and the cause is difficult to determine for a variety of reasons, such as:

- Cancer is at least partly a disease of aging so it is more common as people get older.
- There is not one type of cancer; rather, science has identified more than 100 different kinds of cancer, many of which have different—and most of the time, unknown—causes.
- Some cancer-causing agents, such as tobacco, cause more than one kind of cancer.
- If people in a group or community have many different kinds of cancer, it is less likely that they were caused by the same thing.
- Cancer can take a long time to develop. For adult cancers, unless people have remained in the same geographic area or type of work for many years, it is very difficult to determine if cancers were caused by something in the place where they live and work (or have lived or worked).

There are three (3) considerations the CDC identifies as important for suspected cancer cluster investigations:

- First, types of cancers vary in etiologies (causes), predisposing factors, target organs, and rates of occurrence.
- Second, cancers are often caused by a combination of factors that interact in ways that are not fully understood.
- Third, for the majority of cancers, the long latency period (i.e., the time between exposure to a causal agent and the first appearance of symptoms and signs) complicates any attempt to associate cancers occurring at a given time in a community with local environmental exposures. Often decades intervene between the exposures that initiate and promote the cancer process and the development of clinically detectable disease.

Further, as the CDC has noted, finding a causal association between environmental contaminants and cancer is rare (CDC 1990). Evidence reported by state and local health agencies and federal agencies suggests that most investigations of suspected cancer clusters do not lead to the identification of an associated environmental contaminant.

To provide a framework for responding to suspected cancer clusters, the CDC developed a guideline to systematically define, investigate, collect and analyze data that may be associated with a cluster (CDC 2013). Even if inquiries from the public concerning cluster events meet the statistical criteria for a cancer cluster, investigations of these suspected cancer clusters are unlikely to find an associated environmental contaminant. For example, one of the largest cancer clusters investigated by CDC's National Center for Environmental Health and other agencies concerned cases of childhood leukemia in Fallon, Nevada. Although initial analysis demonstrated

a statistically-significant increase in the number of cases, subsequent epidemiologic investigations did not identify a statistically-significant association with any environmental contaminants (Rubin CS, Holmes AK, Belson MG, et al. 2007).

One common misconception held by those not familiar with the scientific study of cancer is that a single environmental contaminant or chemical is the likely cause of all types of cancer. Toxicologic and epidemiologic studies do not support this concept. Cancer is not one disease; rather, cancer is many different diseases with different causal mechanisms (National Cancer Institute 2013).

In most cancer cluster investigations, information regarding known or suspected environmental contamination and pathways of contamination (air, water, soil) is missing. Navy investigators conducted multiple site scoping and environmental sampling visits to Camp Justice and NSGB over the past 18 months to collect relevant environmental data to characterize environmental and occupational exposures. These data are very important for determining if a person with cancer was actually exposed to an environmental contaminant in sufficient doses and for a sufficient time to make the association biologically plausible. Based on the consensus of the published literature, investigators made a determination whether or not the exposure dose and duration were sufficient to increase the risk of cancer and whether or not the time sequence of exposure was consistent with the latency period of these particular cancers.

Approach Used to Evaluate Cancer Cases at Camp Justice

NMCPHC used the CDC published guidelines to determine if a cancer cluster investigation was warranted and used this process for conducting the investigation. As part of the PHR, the NMCPHC took specific steps to:

- Review medical records for service members named in the original DoD IG complaint to determine if there was sufficient evidence to confirm a diagnosis of cancer (e.g., case validation).
- Review the medical records and claims data for all military personnel assigned to OMC to identify and validate any cancer diagnoses as part of the determination of a cancer cluster. The date of cancer diagnosis was compared to the date of first arrival at Camp Justice from the information provided by OMC, to determine if the cancer diagnosis was after the first arrival and the time that elapsed from first visit to diagnosis.
- Conduct the appropriate type of epidemiologic investigation based on the findings of a medical review and the types of cancer diagnosed. See Appendix E (Epidemiologic Investigation of Cancers Associated with Camp Justice, Naval Station Guantanamo Bay, Cuba) for the full report and details.

For Camp Justice, a formal cancer cluster investigation was not supported because the number and types of cancer cases validated in this review did not meet the minimum criteria recommended by the CDC (CDC 2013). Consequently, a case series analysis was performed. A case series analysis is comprised of the following steps:

Steps 1 and 2: Case Validation and Cancer Type Assessment[20]

The purpose of these steps is to validate/confirm the number and types of cancers that have been observed in the population over a specific time period and specific geographic location.

Step 3: Review the Scientific Literature Regarding the Specific Cancer Types

- **Identify Risk Factors:** The purpose of this step is to identify any *risk factors* that might be common between cancer cases that were reported. A risk factor is anything that increases a person's chance of developing cancer. This may include age, gender, family history, genetic make-up, race and ethnicity, and lifestyle (e.g., diet, exercise, alcohol, smoking). Environmental risk factors include home and work exposure (e.g., solvents, pesticides), exposure to infections, viruses, and allergens, and exposure to ionizing radiation (e.g., x-rays).
- **Describe the Frequency and Incidence in a Population:** The purpose of this step is to identify the frequency at which cancer is observed in populations and cancer-specific incidence rates (e.g., background incidence, age-specific incidence, gender-specific incidence). This information is used to evaluate and assess whether or not the numbers/types of cancers observed in the study exceed what is expected. When the case count is too low to calculate statistically reliable rates, a qualitative assessment is performed.
- **Describe Latency:** Latency is a recognized concept in cancer research and is defined as the time from the exposure(s) that initiate the cancer process to clinical diagnosis. Based on the results of epidemiologic studies, published latency times represent the average time within a population.

Case Series Analysis Results

The results of the case series analysis that was performed for Camp Justice is summarized below:

Steps 1 and 2: Case Validation and Cancer Type Assessment

The case validation and cancer type assessment steps identified four (4) different cancers diagnosed in five (5) individuals who traveled to and worked at Camp Justice. One case was excluded from the analysis because it was a metastatic cancer and the diagnosis of the primary

[20]The case validation/cancer type assessment steps are often combined.

cancer occurred before the date of first arrival at Camp Justice. The four (4) types of cancers identified at Camp Justice were appendiceal adenocarcinoid, breast, colorectal, and myxoid liposarcoma.

Step 3: Review the Scientific Literature Regarding the Specific Cancer Types

- **Risk Factors:** There are no known environmental risk factors for two of the types of cancers at Camp Justice (appendiceal adenocarcinoid and colorectal). The only common risk factor for the other two types of cancers at Camp Justice (breast, myxoid liposarcoma) was exposure to ionizing radiation. Potential sources of exposure to environmental radiation at Camp Justice include non-destructive testing of materials using radioactive sources and naturally occurring radioactive materials like radon.

  No documentation of non-destructive testing using radioactive sources at the former airfield was found. Nevertheless, ionizing radiation exposure was evaluated to include radon at Camp Justice (see Section 3 Ionizing Radiation). Based on the results of the radiation surveys and measurements, it is not likely that an individual would receive any additional radiation dose above normal background radiation from the occupied areas surrounding OMC trailers, tents, offices, and courtroom buildings on Camp Justice at NSGB.

  Other potential exposures to ionizing radiation not specific to Camp Justice include living or working at or near nuclear power plants and exposures from medical diagnostic and treatment equipment. There are no nuclear power plants in Cuba. The history of exposures to medical diagnostic and treatment (x-rays, fluoroscopy, nuclear medicine, Computerized Axial Tomography scans) for these two cancer types is unknown, but the trend toward using these technologies is dramatically increasing. For example, in 2006, Americans were exposed to more than seven times as much ionizing radiation from medical procedures as was the case in the early 1980s (NCRP 2009). In 2006, medical exposure constituted nearly half of the total radiation exposure of the US population from all sources.

  While medical diagnostic procedures are currently the greatest manmade source of ionizing radiation exposure to the general population, even these sources are less than general background radiation on earth. Background radiation (which contributed half of the total exposure in 2006) comes from natural radiation in soil and rocks, radon gas which seeps into homes and other buildings, plus radiation from space and radiation sources that are found naturally within the human body.

  Lastly, review of the HHRA results (Section 2 and Appendix C) did not indicate any significant environmental exposures or elevated human health risks due to environmental exposures.

- **Frequency and Incidence:** An analysis of the frequency of each cancer type could not be conducted and the incidence rates could not be calculated because there was an insufficient number of each cancer type.
- **Latency:** The latency for each of the suspected cases was measured using the first date of arrival at Camp Justice from the OMC roster to the first diagnosis date of the suspected cancer. The known latency periods for these validated cancers is 10 years or greater (the ELC at Camp Justice became fully operational in 2007/2008).

Conclusions

Based on the types and number of cancers observed and the lack of recognized occupational and environmental risk factors, it is unlikely that an environmental or occupational exposure is associated with these cancers. The term "unlikely" means that the evidence is insufficient to connect the environmental and occupational conditions to the observed cancers. Current epidemiologic methods are not adequate to determine if there were other factors (e.g., genetic errors or modifications) in these cases (Bartsch H & Hietanen E 1996).

Section 7: Camp Justice PHR Risk Management Recommendations

This section presents the risk management actions that are recommended based on the results of this PHR. Risk management is the process that determines how to protect public health from risks that were identified in the risk assessment, epidemiology, and other health evaluations performed as part of a this PHR. Risk assessments provide information on potential health risks and risk management is the process of deciding whether or not and how to manage those health risks. Risk management requires consideration of legal, economic, and behavioral factors in making decisions about which risk management actions or alternatives to take to reduce or eliminate identified potential risks where possible.

> This risk management section provides risk managers with the context necessary to make informed risk management decisions. In the absence of any DoD or Navy (Outside of the Continental United States [OCONUS] environmental/public health risk policy guidance for these situations, NMCPHC's approach was to benchmark the study design, risk management criteria, and risk management actions against what would normally occur in the US. This issue (equivalent protection) has evolved over the years to the point where our personnel expect a similar level of environmental and public health protection as would be afforded them in the Continental United States (CONUS).

The resources that have been brought to bear in this DoD IG investigation (FY15 – FY17), or at least a large portion, may not have been necessary if there had been compliance with, or implementation of:

- DoD Expeditionary Occupational and Environmental Health (OEH) Program Requirements (e.g., an Occupational and Environmental Health Site Assessment [OEHSA])
- A fully functioning AMP
- Overseas Environmental Baseline Guidance Document (OEBGD) compliant incinerators
- Follow through on Environmental Management System (EMS) compliance audit findings
- Public health input into funding decisions for environmental programs

The lack of compliance and full implementation resulted in data gaps, which required extensive resources for environmental testing to assess the levels of health risks and to address the DoD IG investigation complaints.

Below is a summary of the risk management recommendations identified in this PHR. A complete list of risk management actions taken to date is provided in Appendix F (NMCPHC Status of

Previous Public Health Review Risk Management Recommendations, February 2017). The recommended risk management actions discussed below are organized into four functional groups:

- **Administrative Recommended Risk Management Actions**: These are risk management actions that are recommended to document actions taken and enduring processes recommended, and to improve risk communication with stakeholders. For example, maintaining the Guantanamo Bay Public Health Website and establishing an Administrative Record for this PHR.
- **Chemical-Specific Recommended Risk Management Actions**: These are risk management actions that are recommended to reduce/eliminate potential risks associated with specific chemicals. For example, addressing formaldehyde in indoor air of modular buildings in Camp Justice.
- **Program-Related Recommended Risk Management Actions**: These are risk management actions that are recommended based on the implementation (or lack of implementation) of programs that are intended to protect human health. For example, implementation of the AMP. These risk management actions address the causes, not the symptoms of the problems identified during the course of the PHR (July 2015 to February 2017).
- **Policy-Related Recommended Risk Management Actions**: These are risk management actions that are recommended to address policies (or implementation of policies) that may impact human health and the environment. These risk management actions also address the causes, not the symptoms of the problems identified during the course of the PHR (July 2015 to February 2017).

Administrative Recommended Risk Management Actions

1. NMCPHC Camp Justice PHR Report (CNIC)

Recommendation: Post this PHR Report on the NSGB Public Health Review website.

2. Camp Justice PHR Documentation (NSGB)

Recommendation: Continue to maintain the NSGB Public Health Review website.[21]

3. Administrative Record (CNIC)

Recommendation: Create a Camp Justice PHR Administrative Record website on the CNIC Portal to document actions taken and enduring processes recommended. Work with the DoN,

[21]https://cnic.navy.mil/regions/cnrse/installations/ns_guantanamo_bay/om/environmental_support/Guantanamo_Bay_PHR.html.

Director of Records, to ensure that the most appropriate standard subject identification code (SSIC) is assigned for the final disposition and records retention period. It is likely these records will require retention to span the amount of time DoN will remain at NSGB.

4. Medical Surveillance (JTF GTMO, USNAVHOSP GTMO)

Recommendation: For Camp Justice personnel, no specific occupational or environmentally-related medical screening is recommended at this time based on the sampling results and the HHRA results.

Please note, for general awareness of health care providers at JTF GTMO and USNAVHOSP GTMO, Navy medical surveillance for occupational exposure is based on OSHA action level exceedances for workers and is contained in the NMCPHC Medical Surveillance Procedures Manual & Medical Matrix (NMCPHC – TM OM 6260 Apr 2016):

http://www.med.navy.mil/sites/nmcphc/occupational-and-environmental-medicine/oemd/Pages/medical-matrix-online.aspx

Also note, for responding to stakeholder concerns regarding general environmental exposures, we recommend health care providers follow the guidance from the US Preventive Services Task Force (USPSTF) Recommendations:

http://www.uspreventiveservicestaskforce.org/BrowseRec/Index

For personnel concerned about their exposure and appropriate medical testing, continue to recommend health screening for eligible beneficiaries in accordance with the USPSTF's Guide to Clinical Preventive Services, which includes recommendations for cancer screening. Beneficiaries should discuss these recommendations with their health care providers. The USPSTF guidelines are already widely used and considered the standard of care within the medical community. The USPSTF, established in 1984 under the US Department of Health and Human Services, has routinely published recommendations for primary care practitioners on the medical testing or procedures that should be provided to apparently healthy persons based on age, sex, and risk factors for disease. The USPSTF's recommendations are general medical screening recommendations that are appropriate for any and all members of the US population and provide early detection of diseases ranging from cancer to mental health conditions.

Chemical-Specific Recommended Risk Management Actions

1. Formaldehyde in Indoor Air of Modular Buildings (OMC)

Discussion: Formaldehyde is frequently found in plywood, fiberboard, insulation, resins, glues and other building materials in modular and stick-frame permanent buildings. The concentrations of formaldehyde detected in indoor air in modular buildings (e.g., Cuzcos) at Camp Justice were within the range of concentrations considered as "Low" to "Mid" by the CDC

for typical concentrations observed in manufactured homes (CDC Fact Sheet 2016). These results indicate that people may be exposed to similar concentrations of formaldehyde in indoor air in buildings in the US. Until such time that replacement of the current modular buildings with low or no formaldehyde alternative modular buildings is accomplished, NMCPHC recommends that certain engineering controls (e.g., HVAC) be implemented to reduce the formaldehyde levels. In April 2016, OMC took risk management actions to reduce the formaldehyde levels and all Cuzcos were modified as follows:

- All bathroom exhaust fans were wired to run continuously (24/7).
- All air conditioner unit coils were cleaned.
- OMC told occupants to keep the bathroom door shut during and immediately after showering and to leave the air conditioners running at all times, set at no more than 72 degrees Fahrenheit.
- Further, occupants were told to use the economy setting so that outside air is brought through the air conditioner instead of just recirculating interior air.
- Signs were posted in the Cuzcos reminding occupants of these guidelines.
- OMC ordered silicone caulk to re-caulk the air gaps.
- OMC requested that air conditioner/dehumidifier combination units be placed on the list of units to purchase. BEEF indicated that it is near time for a life cycle replacement of the air conditioners and are evaluating if now is the proper time to do such a replacement.

Lastly, OMC has begun to systematically replace the air conditioner units and include dehumidifiers.

In April 2016, sampling for formaldehyde in the modular buildings was repeated (original sampling was October 2015) to determine the degree to which the risk management actions above were effective in reducing the formaldehyde levels. Those risk management actions were effective at reducing the formaldehyde levels in almost all locations.

Recommendation: The risk management actions taken to date (i.e., engineering controls) are considered interim until such time that more permanent risk reduction actions are implemented (e.g., replacing existing modular buildings with modular buildings constructed with low or no emission formaldehyde-containing materials).

In addition we recommend engineering/institutional controls be implemented including:

- Develop an SOP for documenting the interim engineering control actions such as inspecting, repairing, and replacing HVAC systems.

- Continue to evaluate and monitor the capacity of the existing air handling (and dehumidifying) equipment in the modular units (e.g., Cuzcos) to ensure adequate ambient air flow is provided while maintaining acceptable temperature (< 72 degree Fahrenheit) and humidity (< 60%).
- Until the modular buildings are replaced, consider sampling formaldehyde in air each summer to verify and demonstrate that engineering controls are effective at keeping formaldehyde levels at current reduced levels.

2. PAHs in Soil Proximate to AV-34 (OMC)

Discussion: The cancer risk for PAHs in soil at all locations were within the USEPA acceptable cancer risk range (i.e., a cancer risk between 1E-06 and 1E-04 [1 in 1,000,000 to 1 in 10,000). However, the highest concentrations of PAHs in soil were detected proximate to Building AV-34. Although there is no documentation available for spill events, the concentrations observed at Building AV-34 may be associated with minor release(s) of petroleum products (e.g., minor spills) to soil.

Recommendation: If intrusive activities (planned or yet unknown) occur which disturb soil in those locations proximate to Building AV-34, a Soil Management Plan (SMP) should be developed to minimize contact with impacted soil and generation of airborne concentrations of benzo(a)pyrene to occupants of Building AV-34 and workers performing the activities. The SMP should provide workers documentation of locations and levels of benzo(a)pyrene in soil for the site, requirements for handling impacted soil and requirements for soil barrier management if required. Workers should be responsible for conducting site work in accordance with the specifications outlined in the SMP and be under the oversight of the NSGB representative. Construction specifications should be approved by NSGB in writing prior to construction activities including excavation for trenches (e.g., utility) and other activities. Earthwork and other necessary construction shall be planned to minimize disturbance of the soil. The SMP should include methods to achieve no visible emissions which may include, but are not limited to equipment speed limits to reduce dust generation, and/or low tipping of excavated loads. Use of a water spray unit to dampen surface materials should be considered if visible dusts are generated during excavation and soil movement. If water spraying is used, construction personnel shall avoid over-spraying the area to prevent run-off and mud-slick work surfaces.

3. Mercury in Building AV-29 (OMC)

Discussion: Building AV-29 was formerly a dental clinic and mercury was detected in indoor air at the floor level (not the breathing zone) which indicates that mercury is likely present in the cracks/crevices between the floor tiles and in sub-flooring materials.

Recommendation: If intrusive activities (planned or yet unknown) occur that may disturb floor tiles/flooring/plumbing/piping (e.g., remodeling) inside Building AV-29, appropriate measures performed by trained personnel should be implemented to ensure the health and safety of occupants of Building AV-29 and workers performing the activities. For example, a mercury materials management plan and mercury sampling plan (including collecting indoor air samples) should be developed to minimize generation of airborne mercury.

Program-Related Recommended Risk Management Actions

1. Asbestos Management Program (NSGB, USNAVHOSP GTMO)

Discussion: The AMP is not fully implemented at NSGB, which affects the ability of Camp Justice, a tenant command, to comply with the responsibilities under this program. Recently, NSGB signed out a new installation instruction for managing asbestos, applicable to all NSGB departments and tenant commands (NSGBINST 5090.8 – 2 February 2017 – Asbestos Program Management).

Recommendation: As soon as possible, NSGB should fund and implement the recommendations as identified in the Naval Facilities Engineering Command Southeast (NAVFAC SE) 5 January 2017 NSGB AMP Review Report. US Naval Hospital Guantanamo Bay (USNAVHOSP GTMO) continue to maintain laboratory capabilities for asbestos identification and quantification using polarized light microscopy (PLM) and phase contrast microscopy (PCM) as required.

2. NSGB MSW Management Program (SOUTHCOM, NAVFAC SE, NSGB)

Discussion: NSGB currently uses ACIs (or burn boxes) to burn MSW at the landfill. As noted in multiple NAVFAC SE oversight EMS Audits (2008, 2011, 2014 and 2016) and Office of the Navy Inspector General (NAVINSGEN) area visit reports (1994, 1997, 1998, 2000, and 2007), these ACIs are not in compliance with DODI 4715.05-G (Overseas Environmental Baseline Guidance Document) for municipal waste combustion (MWC) units which must comply with the applicable emission standards and operating limits. NSGB's waiver from SOUTHCOM to continue to use ACIs to burn solid waste expired in May 2000. CNRSE recently (Aug 2015) endorsed an NSGB waiver application to SOUTHCOM which would allow continued use of the non-compliant incinerators until compliant facilities are in place, or 2021, whichever occurs first. SOUTHCOM approved the waiver on 6 January 2016 for a period of one year with direction to continue to develop a plan of action and milestones (POA&M) for correction of non-compliance and provide SOUTHCOM a monthly progress report. The waiver will be reevaluated each year with the possibility of extension so long as CNRSE continues to abide by the POA&M. This was endorsed

by CNRSE on 3 November 2016 and by US Naval Forces Southern Command on 10 November 2016, and SOUTHCOM granted an extension of the waiver to 6 January 2018.

Accordingly, a DoD Form 1391 has been submitted for the Program Objectives Memoranda (POM) Fiscal Year 2019 Military Construction (MILCON) Cycle for the solid waste management solution for the NSGB. The project includes construction of a new 15-acre, lined MSW landfill with a leachate collection system, a waste sorting/processing facility, new lined sewage ponds, and the associated utilities upgrades to support the new facilities. The project is currently awaiting preliminary design authority to continue on to the detailed design phase. The landfill is expected to take 5 – 7 years for completion.

On 28 October 2016, NSGB (CO NSGB ltr 5090 N00 28 Oct 16) requested renewal of the waiver to the Final Governing Standards (FGS) to continue to operate the ACIs through 31 January 2021. This was endorsed by CNRSE on 3 November 2016 and by US Naval Forces Southern Command on 10 November 2016 and is now under consideration by SOUTHCOM.

Recommendation: SOUTHCOM should continue to review and monitor the POA&M for correction of non-compliance and the monthly progress report, and reevaluate the waiver each year with the possibility of extension so long as NSGB continues to make progress toward completing the landfill as the ultimate solution to the MSW Program.

3. Deployment Health Program - Perform Occupational and Environmental Health Site Assessments (SOUTHCOM, JTF GTMO)

Discussion: SOUTHCOM oversight for execution of deployment health requirements occurs in the Command Surgeon's Office under the Command Group who are Special Staff to the Commander.[22] It is the Combatant Commander's responsibility to identify all deployment health resource requirements to include "*Direct and document health risk assessments (including food and water risk assessments) and OEH site assessments, and determine required deployment health activities for the joint operations area or area of operations based on health threats*."[23] At the time of our initial visit (Aug 2015), there was no planned OEHSA identified or completed for Camp Justice.

Recommendation: Determine what environmental, occupational, and safety health standards apply at Camp Justice and how those services will be provided to fill the gaps in coverage, and ensure continuous coverage into the future. SOUTHCOM/JTF GTMO, as per DoD 6490.03

[22] DoDI 6490.03 Deployment Health, DoDI 6055.05 Occupational and Environmental Health, and Joint Chiefs of Staff Memorandum MGM 0028-07 Procedures for Deployment Health Surveillance.

[23] DoDI 6490.03 Deployment Health.

(Deployment Health), submit the NMCPHC Final PHR Report as an OEH Exposure Incident Report (IR) to the Defense Occupational and Environmental Health Readiness System – Industrial Hygiene (DOEHRS-IH), to satisfy the OEHSA requirement.

Policy-Related Recommended Risk Management Actions

1. Determine if Camp Justice is an Expeditionary Camp or Fixed Naval Installation (SOUTHCOM, JTF GTMO)

Discussion: Camp Justice is an Expeditionary Camp, which is located on and is surrounded by NSGB, a fixed naval installation with a fixed military treatment facility. As a result of this unique arrangement, the PHR addressed several of the environmental and occupational health compliance issues pertinent to the DoD IG complaint. The discussion below provides programmatic requirements for both designations (i.e., a fixed naval installation and Expeditionary Camp), as well as recommendations based on observations and information obtained during the conduct of the PHR (July 2015 – Jan 2017).

Fixed Naval Installation Requirements

For fixed naval installations ashore, environmental and occupational health program requirements and Budget Submitting Office (BSO) responsibilities are contained in the following documents:

- Office of the Chief of Naval Operations Instructions (OPNAVINST) 5090.1D (10 January 2014, Environmental Readiness Program Manual); and
- OPNAVINST 5100.23G (CH-1 - 21 July 2011 – Navy Safety and Occupational Health Program Manual).

In addition, overseas programs and requirements in Cuba are contained in the following documents:

- DoD 4715.05-G (1 May 2007, Overseas Environmental Baseline Guidance Document)
- Environmental Final Governing Standards Cuba October 2016 (cancels Final Governing Standards for Cuba of September 1994)

A few of these programs (e.g., AMP), have program and BSO responsibilities in all of these policy instructions as they pertain to both human health and the environment.

Expeditionary Camp Requirements

For Expeditionary Camps, program requirements are contained in:

- DoDI 6490.03 (11 August 2006 - Deployment Health);

- DoDI 6055.05 (11 November 2008 - Occupational and Environmental Health);
- Joint Chiefs of Staff Memorandum MGM 0028-07 (2 November 2007 - Procedures for Deployment Health Surveillance); and
- DoDDir 6490.02E (3 October 2013 – Comprehensive Health Surveillance).

Specific to the SOUTHCOM Area of Responsibility (AOR) and Camp Justice, program requirements are also contained in:

- USSOUTHCOM Message of 5 October 2016 (Force Health Protection (FHP) Guidance for Deployment in USSOUTHCOM AOR as of 5 October 2016)

Neither the Fixed Naval Installation nor the Expeditionary Camp OEH requirements (listed above) have been fully implemented at Camp Justice. Further complexity is added unnecessarily with requirements specified in the Interservice Support Agreement (ISSA – N60514-20150819-0015 1 Oct 2015 – 30 Sep 2017) between NSGB and JFT GTMO which stipulates compliance with fixed naval installation environmental, safety and health requirements, and expeditionary deployment health requirements. Practically speaking, this is not feasible or logical from a health protective perspective, and is not what is intended by these DoD and USN policy documents. See Figure 5-2, which lists the types of personnel and periodicity of working and living on Camp Justice which contributes to the confusion of status.

This inability to fully implement both expeditionary and fixed requirements creates confusion and compliance liability issues and increases the potential for health risks from exposures to hazardous substances to workers (active duty, civil service, contractors) and their families.

Recommendation: Determine if Camp Justice is an Expeditionary Camp or Fixed Naval Installation. Obtain resources required to support applicable environmental and occupational programmatic requirements.

2. Establish an Environment, Safety, and Health Professional at OMC Headquarters (OMC)

Discussion: Since OMC (and OMC South) has no established environment, safety or health personnel or programs, it must rely on a combination of JTF GTMO, NSGB, and USNAVHOSP GTMO subject matter experts for these services using a variety of support arrangements (e.g., ISSA). Because there has been no clear declaration of exactly what environmental, occupational, and safety health standards and surveillance apply to Camp Justice, OMC is vulnerable to varying interpretations and execution of requirements which has resulted in some gaps in coverage.

Recommendation: Consider establishing an environment, safety, and health position at OMC headquarters to oversee, determine and de-conflict support services OMC receives from JTF GTMO, NSGB, and USNAVHOSP GTMO.

3. Revise the Environmental Funding Process to include Public Health Input (CNO, CNIC, NAVFAC, BUMED)

Discussion: The DoN budgeting process for environmental programs for the annual POM Budget Estimate Submission (BES) process, and funding decisions made during the execution year, is complex and includes input from a variety of organizations from the installation (NSGB) to the region (CNRSE) to the BSO (CNIC, NAVFAC) to the Resource Sponsor (CNO N45 [Energy and Environmental Readiness Division]). Nowhere in this process is there input from BUMED public health experts. Consequently, the public health impact to our active duty personnel, our civil service, their families and the public when deciding what to fund and at what level, is not considered. This PHR identified funding decisions that, had they been discussed with appropriate public health experts, may have eliminated the need for this PHR.

For DoN there is neither opportunity nor mechanism in the POM or execution year process that requires consultation or discussion with BUMED if another BSO's program area risk assessment is less than environmental readiness level (ERL) 4, or if the region or installation decides not to execute (or partially execute) a program area/project. Consequently there is no input from BUMED as to how that potentially affects the level of health risk to workers, their families, and at times, the general public. The lack of input results in non-medical personnel making decisions with potential health risk consequences. This could also be perceived as non-medical personnel making assumptions for health risks for others (workers, families) without their knowledge and consent. Lack of input could potentially result in one, some, or all of the negative outcomes below:

- Increased health risk;
- Perception of increased health risk and/or concern from stakeholders;
- Increased negative coverage from media/social media;
- Increased Congressional scrutiny and legislation;
- Exploitation by individuals or groups with agendas;
- Diminished organizational trust, credibility, and reputation;
- Increased potential for external third party peer review scientific investigations (Government Accountability Office [GAO], ATSDR, TNRC);
- Increased potential for legal action lawsuits (civil action, tort, personal injury);
- Increased potential for compensation for actual or perceived health effects (Veterans Administration);
- Increased pressure to create a DoD exposure registry (e.g., Burn Pits, Chemical Warfare Agent, Tomodachi); and
- Significant expenditure of non-programmed resources to respond to the issue.

Lack of input can also result in the use of unplanned/unprogrammed resources, which have to be brought to bear quickly, and sometimes for sustained periods, until the issue is finally corrected or the program area is in full compliance, like this Camp Justice PHR effort. Other recent examples include the Navy's Radon Assessment and Mitigation Program (NAVRAMP) and Sampling and Testing for Lead in Drinking Water in Priority Areas Program (LIPA).

The resources having to be brought to bear in this DoD IG investigation (FY15 – FY17), or at least a large portion of them may not have been necessary if there had been compliance with:

- DoD Expeditionary OEH Program Requirements (e.g., an Occupational and Environmental Health Site Assessment)
- A fully functioning AMP
- OEBGD-compliant incinerators

The lack of compliance and full implementation resulted in data gaps, which required extensive resources for environmental testing to assess the level of health risk to address the DoD IG investigation complaint.

This also extends into lack of public health input into the DoN environmental program oversight process. Even though discrepancies regarding the AMP and non-compliant ACIs were documented in multiple USN EMS audits at NSGB and NAVINSGEN area visits, this did not result in adequate oversight and correction.[24] See Appendix F for further detailed documentation on these two issues. EMS is the USN's primary system for maintaining environmental compliance at USN shore activities, reducing the number of notices of violation (NOVs), improving environmental quality, and achieving P2 goals. The Navy EMS is a formal management framework that provides a systematic means of reviewing and improving operations, creating awareness, and improving environmental performance. The USN's EMS is based on the International Standards Organization (ISO) 14001 model, which employs a cycle of policy, planning, implementation and operation, evaluation and corrective actions, to include both internal and external management reviews at each and every level (CNO – BSO – Region – Installation).

[24] OPNAVINST 5090.1D (10 Jan 2014, Environmental Readiness Program) Chapter 17 – Environmental Management.

Recommendation: As described above, this method for environmental funding is not a sustainable corporate policy. The disconnect in both funding and oversight processes, which creates potential public health issues, needs to be eliminated by including public health subject matter experts (e.g., BUMED) into the decision-making process. DoN should ensure public health subject matter experts (e.g., BUMED) are included in the Resource Sponsor's (OPNAV N45), BSO's, Region and installation decision making process when the potential for increased health risks is identified in the oversight (EMS) process, the POM workup, or at any time during the execution year in a particular program area.

Section 8: References

Alfaro, M.R., A. Montero, O.M. Ugarte, C.W.A. do Nascimento, A.M. de Aguiar Accioly, C.M. Biondi, Y.J.A.B. da Silva. 2015. Background concentrations and reference values for heavy metals in soils of Cuba. Environmental Monitoring and Assessment, 187: 4198. January

American Cancer Society. 2011. Colorectal Cancer Facts & Figures 2011-2013. Atlanta: American Cancer Society.

American Cancer Society. 2015a. What are the risk factors for breast cancer? http://www.cancer.org/cancer/breastcancer/detailedguide/breast-cancer-risk-factors. Last Revised: 08/19/2015. Accessed on 18 November.

American Cancer Society. 2015b. What are the risk factors for soft tissue sarcomas? http://www.cancer.org/cancer/sarcoma-adultsofttissuecancer/detailedguide/sarcoma-adult-soft-tissue-cancer-risk-factors. Last Revised: 03/16/2015. Accessed: 4 August 2015.

American Cancer Society. 2016. What are the risk factors for colorectal cancer? http://www.cancer.org/cancer/colonandrectumcancer/detailedguide/colorectal-cancer-risk-factors. Last Revised: 02/27/2015. Accessed on 18 November.

American Society of Clinical Oncologists. 2016. http://www.cancer.net/cancer-types/appendix-cancer/risk-factors. Accessed on 18 November 2016.

Armed Forces Health Surveillance Center. 2012. Incident Diagnoses of Cancers and Cancer-related Deaths, Active Component, US Medical Surveillance Monthly Report. Vol. 19(6), June. Pages 18-22.

ATSDR 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. US Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. August.

Bartsch, H., & Hietanen, E. 1996. The role of individual susceptibility in cancer burden related to environmental exposure. Environmental Health Perspectives, 104 Suppl 3, 569–577. http://doi.org/10.1038/nature05887CDC. 2013. Investigating Suspected Cancer Clusters and Responding to Community Concerns Guidelines from CDC and the Council of State and Territorial Epidemiologists MMWR 2013; 62(No. RR-8). September 27, 2013

BUMEDINST 6200.14C. 2014. Childhood Lead Poisoning Prevention. 21 July.

CDC 1990. Guidelines for investigating clusters of health events. MMWR 1990; 39(No. RR-11).

CDC 2013. Investigating Suspected Cancer Clusters and Responding to Community Concerns: Guidelines from CDC and the Council of State and Territorial Epidemiologists - Morbidity and Mortality Weekly Report September 27, 2013 / 62(RR08); 1-14.

CDC Fact Sheet [No Date Provided]. "What You Should Know about Formaldehyde". http://www.cdc.gov/nceh/drywall/docs/WhatYouShouldKnowaboutFormaldehyde.pdf. Last accessed: 12 Feb 2016.

Checkoway, H., Dell, L.D., Boffetta, P., Gallagher, A.E., Crawford, L., Lees, P., and Mundt, K. 2015. Formaldehyde Exposure and Mortality Risks From Acute Myeloid Leukemia and Other Lymphohematopoietic Malignancies in the US National Cancer Institute Cohort Study of Workers in Formaldehyde Industries. Journal of Occupational and Environmental Medicine 57: 785.

CNIC. 2013. Memorandum 5200 Ser N4/13U84375, Determination of Fit for Human Consumption and Public Notification for the Navy Overseas Drinking Water Program, August.

IARC. 2012. Chemical agents and related occupations. IARC monographs on the evaluation of carcinogenic risks to humans (Formaldehyde). 100:401-35.

International Atomic Energy Agency. 2010. Naturally Occurring Radioactive Material (NORM VI). Proceedings of an International Symposium. Marrakesh, Morocco, 22-26 March.

Jardines, L., Goyal, S., Fisher, P., Weitzel, J., Royce, M., Goldfarb, S.B. 2015. Breast cancer overview: risk factors, screening, genetic testing, and prevention. http://www.cancernetwork.com/cancer-management/breast-cancer-overview-risk-factors-screening-genetic-testing-and-prevention/. 01 June. Accessed on 18 November 2016.

Joint Chiefs of Staff Memorandum MGM 0028-07. 2007. Procedures for Deployment Health Surveillance. 02 November.

Marsh, GM; Morfeld, P; Zimmerman, SD; Liu, Y; and Balmert, LC. 2016. An updated re-analysis of the mortality risk from nasopharyngeal cancer in the National Cancer Institute formaldehyde worker cohort study. Journal of Occupational Medicine and Toxicology (2016) 11:8

Möhner, M and Wendt, A. 2016. A diagnostic bias might be a much simpler explanation for the apparently elevated risk for nasopharyngeal cancer with respect to formaldehyde. Journal of Occupational Medicine and Toxicology 11:54.

National Cancer Institute. 2013. Defining cancer. Bethesda, MD: National Cancer Institute; 2013. Available at http://cancer.gov/cancertopics/ cancerlibrary/what-is-cancer.

National Research Council of the National Academies. 2006. Health Risks from Exposure to Low Levels of Ionizing Radiation. BEIR VII PHASE 2. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. Board on Radiation Effects Research. The National Academies Press.

NAVFAC SE. 2017. Naval Station Guantanamo Bay (NSGB) Asbestos Management Program Review Report. 5 January.

NCRP. 2009. Ionizing Radiation Exposure of the Population of the United States. Bethesda, MD: NCRP Report 160.

Neuhaus SJ, Pinnock N, Giblin V, Fisher C, Thway K, Thomas JM, Hayes AJ. 2009. Treatment and outcome of radiation-induced soft-tissue sarcomas at a specialist institution. Eur J Surg Oncol, 35: 654-659.

NMCPHC. 2015. Public Health Review Report for Camp Justice. 21 August.

NMCPHC. 2016a. Epidemiologic Investigation of Cancers Associated with Navy Hotline Request 201502145. Report Number: NMCPHC-EDC-TR-381-2015. November.

NMCPHC. 2016b. Preliminary Public Health Screening Risk Assessment Report for Camp Justice. 23 February.

NMCPHC. 2017. Naval Station Guantanamo Bay Human Health Risk Assessment for Camp Justice. February.

OPNAVINST 5100.23. 2011. Navy Safety and Occupational Health Program Manual - Chapter 17 - Asbestos Control. July.

OPNAVINST 5090.1D. 2014. Environmental Readiness Program Manual – Chapter 25 - Toxic Substances Control Act. 10 January.

PIONEER. 2008. US Navy Human Health Risk Assessment Guidance. December.

Resolution Consultants. 2015. Indoor Air Quality Assessment Report – Office of Military Commissions- Camp Justice – Naval Station Guantanamo Bay, Cuba. 29 October.

Resolution Consultants. 2016a. Environmental Investigation Report - Office of Military Commissions - Camp Justice – Naval Station Guantanamo Bay, Cuba. 11 April.

Resolution Consultants. 2016b. Overseas Baseline Environmental Assessment Report - Office of Military Commissions - Camp Justice – Naval Station Guantanamo Bay, Cuba. 7 April.

Rubin, C., Holmes, A., Belson, M., et al. 2007. Investigating childhood leukemia in Churchill County, Nevada. Environ Health Perspect 2007; 115:151–7.

Schottenfeld D, Fraumeni, Jr JF. 2006. Cancer: Epidemiology and Prevention, 3rd Edition. Oxford University Press. Pages 3-8.

TNRC. 2014. Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens, available at: Caution-https://www.nap.edu/download/18948#

USEPA 1989. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part A). Office of Emergency Remedial Response, Washington, D. C. Publication: USEPA/540/1-89/002. https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part

USEPA 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Washington, D.C. OSWER Directive 9355.0-30. https://www.epa.gov/superfund/key-principles-superfund-remedy-selection.

USEPA 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. USEPA Office of Solid Waste. September.

USEPA 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Retrieved from https://www.epa.gov/risk/regional-screening-levels-rsls

USEPA. 2017. IRIS Toxicological Review of Benzo(a)pyrene. Final Report. 20 January. Retrieved from http://usgov.info/2017/01/19/iris-toxicological-review-of-benzoapyrene-final-report/

WHO. 2001. Air Quality Guidelines - Second Edition. Chapter 5.8 Formaldehyde. Geneva.

WHO. 2002. Concise International Chemical Assessment Document 40: FORMALDEHYDE. Geneva.

WHO. 2010. Formaldehyde. In: Selected pollutants. WHO Guidelines for Indoor Air Quality. WHO, Regional Office for Europe, Copenhagen, Denmark, pp 103-156. ISBN 978 92 890 02134.